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Volume III

V/STOL DYNAMICS AND AEROELASTIC ROTOR-AIRFRAME TECHNOLOGY

Volume III. User's Manuals – Computer Programs for Aeroelastic Stability Analysis and Aeroelastic Prop/Rotor Loads Analysis

A. K. Amos
F. J. Tarzanin

The Boeing Company, Vertol Division

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FOREWORD

This report was prepared by The Boeing Company, Vertol Division of Philadelphia, Pennsylvania, for the Aerospace Dynamics Branch, Vehicle Dynamics Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio, under Contract F33615-71-C-1310. This research is part of a continuing effort to develop new and improved techniques for defining dynamic and aeroelastic phenomena for rotor/propeller-powered V/STOL flight vehicles under the Air Force Systems Command's exploratory development program. This contract was initiated under Project 1370, "Dynamic Problems in Military Flight Vehicles," Task 137005, "Prediction and Control of Flight Vehicle Vibration." Mr. A. R. Basso of the Aerospace Dynamics Branch was the Project Engineer.

The final report is presented in three volumes. The first volume contains a state-of-the-art review of stability and blade vibratory loads in V/STOL aircraft. The second volume contains the development of the analytical methods, the correlation of analytical results with experimental data, and the results of parametric investigations. The third volume contains a user's guide to the digital computer programs including input and output formats. The third volume is not being distributed; however, it is available upon request from the Air Force Flight Dynamics Laboratory/FYS, Wright-Patterson Air Force Base, Ohio 45433.

Mr. H. R. Alexander was The Boeing Company, Vertol Division Project Engineer.

This report covers work conducted from February 1971 through February 1972. The manuscript was released by the authors in February 1972 for publication as an AFFDL Technical Report.

This Technical Report has been reviewed and is approved.

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ABSTRACT

This report provides user's instructions for two computer programs, one for aeroelastic stability analysis and one for aeroelastic prop/rotor loads analysis. These programs are commonly identified by Boeing-Vertol as C-39 and C-70, respectively. Each program is carefully described and explained, symbols and sign conventions are identified, and input and output data are presented. A sample program run for each analysis is then given. In addition, sample programs for subroutines D-01 and A-97, which are used in support of C-70, are provided. Notes and suggestions on program usage are presented.

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Part I. User's Manual: Computer Program for Aeroelastic Stability Analysis

A. K. Amos

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INTRODUCTION

The program is designed to generate and solve a set of equations representing flutter and vibration states of dynamic equilibrium of a general rotored aircraft system following an arbitrary perturbation from a known steady state configuration. In matrix notation, these equations are represented by

$$\left[-[M] + i\lambda([C] + \Gamma_I[A_I]) + \lambda^2([K] + \Gamma_R[A_R])\right]\{q\} = \{o\}$$

where [M], [C], and [K] are generalized inertia, damping and stiffness matrices arising from the structural dynamics of the entire system and the aerodynamics of the rotor blades;

$[A_R]$ and $[A_I]$ are coefficient matrices arising from the aerodynamics of the airframe lifting surfaces;

{q} is a vector of system freedoms (generalized coordinates);

λ is a complex scalar parameter;

Γ_R and Γ_I are real scaling factors; and

i is the imaginary number $\sqrt{-1}$.

The aircraft model on which the program is based comprises three major subsystems identified as (i) Rotor, (ii) Airframe, and (iii) Landing Gear Subsystems.

The rotor subsystem is made up of two rotor-nacelle units. Each rotor has three or more non-articulated flexible blades attached to a teetering hub. Steady state rotor configurations are presumed to involve large blade deflections in flap, lag and twist, and any arbitrary inclination of the shaft axis with the direction of flight. This last feature permits treatment of tilt rotor configurations ranging from hover to forward flight conditions. Physically the rotors may be supported anywhere in the airframe and coordinates are provided for specifying the support locations for each application. Thus both helicopter and rotored conventional aircraft systems are represented by the general model of the program.

The airframe subsystem has the following components: - right wing, left wing, fuselage, right tail, left tail, and fin. Except for the fuselage, all the components are treated as lifting surfaces. The steady state airframe configuration is specified by sets of coordinates capable of representing a wide variety of practical aircraft systems. For example wing "tilt" and "sweepback" angles

of aircraft systems having these features will be reflected in the coordinates for the wing components. Wing or tail dihedral angle has, however, not been provided for.

The landing gear subsystem consists of four linearized oleo-strut-tire units. Their points of attachment in the airframe are identified by sets of coordinates to be specified for the particular systems being analyzed.

The analytical basis of the program lies in

(i) Modal representation of system deviations from steady state equilibrium configurations;

(ii) A basically conservative system under such deviations;

(iii) Two-dimensional quasi-static aerodynamic theory for the rotor blades;

(iv) Two-dimensional oscillatory aerodynamic theory for the airframe lifting bodies; and

(v) Linearly visco-elastic oleo struts and tires.

PROGRAM FEATURES

SYSTEM DEFINITION

The aircraft model previously described has been devised to furnish a general framework representative of a large class of practical systems. To this end the system components and their steady state configurations have been characterized by general coordinates with wide ranges of specification. In addition, a number of bi-valued parameters (option indices) have been provided for eliminating from or retaining in the model entire components or subsystems in adapting it to specific cases.

Each of the two rotors can be retained or deleted to provide representation of systems with fewer than two rotors. For programming purposes the rotors have been numbered 1 and 2 respectively with the first having a higher priority of retention over the second. Thus for a single rotored system ROTOR #1 (rather than #2) MUST be specified as RETAINED (see "Input Data" Section).

The airframe components can each be specified as present or not present depending on the particular system being analyzed. A half aircraft analysis, for example, is achieved by specifying one wing and one tail (both being either right or left) as absent, and by supplying fuselage and fin characteristics representative of half the items.

The actual number (not exceeding four) of landing gears in the particular system being analyzed is specified as input to the program which then limits the analysis to just that many gears.

MODES AND SYSTEM FREEDOMS

Perturbations of the system about its steady state equilibrium configuration are represented by a number of modes falling into three basic categories. The first is made up of BLADE VIBRATORY MODES. They are characterized by flap, lag and twist components at all points of the blades; frequencies of natural vibration at specified rotational speeds; and optionally, some measure of modal damping. Each mode is associated with a COLLECTIVE and 1P CYCLIC ROTOR FREEDOMS. There are thus three rotor freedoms per blade mode.

AIRFRAME MODES constitute the second category. They are defined for each point of the system including the rotor blades (after blade modes have been accounted for). Each is associated with a single airframe modal freedom. The third category of modes arises from the landing gears with each mode defined to produce no displacements

anywhere except at one of the gear sprung masses where it gives rise to a vertical displacement of unit magnitude. Each of the gears is thus affected by only one mode and hence one degree of freedom.

LOOPING

The program features automatic cycling (looping) through the analysis for several problem cases representing parametric variations in some of the system characterizations. In usage, a full set of input data is supplied for the first case and only updates of a group of pre-established data items for all subsequent cases. Five such groups of data as described below are available for optional selection.

OPTION 1: Aircraft velocity components as well as air density and the speed of sound vary from case to case.

OPTION 2: Rotor RPM and steady state blade deflections for all rotors present are updated for each case.

OPTION 3: The items in options 1 and 2 together are updated for each case.

OPTION 4: Updated items consist of the modal frequencies and damping factors for the elastic modes of the system.

OPTION 5: The landing gear properties are updated for each case.

INPUT DATA

The program accepts data on cards only. All data items must be based on a slug-foot-second set of units. However, rotational velocities and frequency items are input as either RPM or radians per second as indicated later in this section.

The input data has been arranged in groups as described below:

Data Group A: Program Definition: Specifies the problem title, the six components of rigid displacement, and a series of logical data to define the general features of the current program application. This group is required for all runs.

Data Group BI: Rotor Configuration Definition: Includes parameters for defining the rotor subsystem as to the number of rotors involved, their mode of operation, and the blade mode freedoms to be considered in the analysis. Each of the three modal freedoms (collective, cyclic yaw, cyclic pitch) for any of the blade modes provided can be arbitrarily eliminated from the analysis where this is desirable in obtaining a realistic representation of the rotor system.
The group must be specified for all runs.

Data Group BII: Rotor Data Set No. 1: This group is not required if no rotors are involved in the analysis. It contains numerical data for all the characteristics of the first (and for identical rotors, the second) rotor in the system.

Data Group BIII: Rotor Data Set No. 2: This group of data is required only when two dissimilar rotors are involved in the analysis. It is not required for a single rotor or a pair of geometrically identical and operationally similar rotors. In the later case the first set applies to both rotors.

Data Group BIV: Nacelle No. 1 Parameters: Geometrical and basic dynamic properties of the first nacelle in the system are here defined. It is presumed that this nacelle and Rotor No. 1 are parts of the same physical unit and a nacelle-rotor coupling between them is automatically generated using data specified separately for each.

Data Group BV:	Nacelle No. 2 Parameters: Repetition of the previous group for the second nacelle if present. Otherwise this group must be eliminated.
Data Group CI:	Airframe Configuration Definition: Required for all runs, it specifies the airframe components present in the analysis.
Data Group CII:	Right Wing Parameters: Required if this component has been specified present in CI. Otherwise omit entire group.
Data Groups CIII Through CVII:	Parameters for Other Airframe Components: Same items (with some modifications) as defined for Group CII but applicable to the other airframe components in order. However, they are included in the data package only if the components they apply to have been specified in CI as present.
Data Group CVIII:	Airframe Modal Frequencies and Damping Factors: The modal frequencies of the airframe elastic modes and the corresponding damping factors due to the airframe structure are specified here. Entire group must be eliminated if no elastic modes are present.
Data Group D:	Landing Gear Properties: Not required if no landing gears are involved in the analysis.
Data Group E:	Airframe Aerodynamics Supplemental Data: Comprises sweepback angles for the airframe lifting bodies and a reduced frequency for the first solution case. When airframe aerodynamics are being ignored in the analysis, this group of data must be eliminated.
Data Groups FI, FII...FV:	Data Updates for Looping Options 1 Through 5: The group of data appropriate to the looping option previously selected is repeated for each solution case following the first.

Following is a tabulation and description of the input data items and their governing input formats.

DATA GROUP A: Required for all runs

A-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO	ENTRY NO.	DESCRIPTION
1	1	1	1	72 Alpha-Numeric Characters: Cols 1-72	1	1	Problem Title
2	1	6	1 Thru 6	Floating Pt. Numbers in Successive Fields of 13 Cols Each Starting From Col 1	1	1	Rigid Mode Shape: Long.Transl. (See Note #1 p. 40)
						2	Rigid Mode Shape: Lat.Transl. (See Note #1 p. 40)
						3	Rigid Mode Shape: Vert.Transl. (See Note #1 p. 40)
						4	Rigid Mode Shape: Roll (See Note #1 p. 40)
						5	Rigid Mode Shape: Pitch (See Note #1 p. 40)
						6	Rigid Mode Shape: Yaw (See Note #1 p. 40)
3	1	16	1	Fixed Pt. numbers right justified in succ.fields of 5 Cols. each starting from Col 1	1	1 thru 6	Retention indices for the rigid modes in the order specified above. Enter 1 : to retain, 0 : to delete corresp. mode
						7	No. of rotor data sets(0, 1 or 2)
						8	No. of elastic modes(0 to 6 incl.)
						9	No. of landing gears(0 to 4 incl.)
						10	Looping option number(1 to 5 incl.)
						11	Continuation index Enter 0 : to terminate after 1st case 1 : to continue after 1st case

A-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
						12	Print Option: Rotor contributions to coeff. matrices
						13	Print Option: Airframe contributions
						14	Print Option: Landing Gear Contributions
						15	Print Option: Final Coeff.Matrices Enter 1 : to print, 0 : not to print } Entries 12 - 15
						16	Solution Mode Selector Enter 1 : for flutter solution; 0 : n vibration solution

DATA GROUP BI: Required for all runs

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	3	14 MAX.	1 thru 14	Fixed point right justified in succ. fields of 5 Cols. each starting in Col. 1	1	1	No. of Blade Modes (0 thru 4 incl.)
							Retention Index for
						2	Collective Freedom; Blade Mode #1
						3	Collective Freedom; Blade Mode #2
						4	Collective Freedom; Blade Mode #3
						5	Collective Freedom; Blade Mode #4
						6	1P Cyclic Yaw Freedom; Blade Mode #1
						7	1P Cyclic Yaw Freedom; Blade Mode #2
						8	1P Cyclic Yaw Freedom; Blade Mode #3
						9	1P Cyclic Yaw Freedom; Blade Mode #4
						10	1P Cyclic Pitch Freedom; Blade Mode #1
						11	1P Cyclic Pitch Freedom; Blade Mode #2
						12	1P Cyclic Pitch Freedom; Blade Mode #3
						13	1P Cyclic Pitch Freedom; Blade Mode #4
							Enter 1: to retain, 0: to delete } Entries 2 - 13
						14	Induced velocity option: Enter 1: to include, 0: to exclude
					2	1	Retention Index: Rotor Teetering Pitch Freedom
						2	Rotor Teetering Yaw Freedom
						3	Roll Perturbation Freedom
							Enter 1: to retain, 0: to delete } Entries 1 - 3

BI-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
					3	1	Rotor 1 present/absent index } 1=Present
						2	Rotor 2 present/absent index } 2=Absent
						3	Rotor 1 operative/inoperative index 1=Oper.
						4	Rotor 2 operative/inoperative index 2=Inop.
						5	Rotor 1 direction of rotation 1 = Clockwise
						6	Rotor 2 direction of rotation 2 = Counter-clockwise viewed from behind.
						7	Print option for rotor derivatives Enter 1 : to print 2 : not to print
2	1 or 2	1	1	40 Alpha-numeric characters: Cols 1-40	1	1	Rotor 1 Description } omit if only 1 rotor present
						2	Rotor 2 Description } omit if only 1 rotor present
3	1	5 (MAX)	1	Floating pt in succ. fields of 13 cols ea. starting in Col. 1	1	1	Air density in slugs/ft^3 } See Fig. 1
						2	Speed of sound in ft/sec } See Fig. 1
						3	A/C speed component parallel to A/C X axis (ft/sec) } See Fig. 1

BI-3

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
				This format will henceforth be designated standard		4	A/C speed component parallel to A/C Y axis (ft/sec) See Fig. 1
						5	A/C speed component parallel to A/C Z axis (ft/sec)
4	1	2	1 & 2	Fixed pt. right justified numbers in fields of 5 Cols. ea starting in Col. 1	1	1	Index pertaining to "ALPHA DOT" terms in Rotor Aerodynamics: 1 = Include, 0 = Exclude terms
						2	Index pertaining to compressibility correction in Rotor Aerodynamics: 0 = Correction applied as necessary, 1 = Correction not applied.

DATA GROUP BII: Omit if Entry No. 7 on Card 3 of Data Group A is zero.

BII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY DESCRIPTION ENTRY NO.	ENTRY DESCRIPTION DESCRIPTION
1	1	2	1 & 2	Fixed pt. right justified numbers in fields of 5 Cols. ea starting in Col. 1	1	1	No. of blades
						2	No. of blade segments (10 maximum)
2	1	5	1 thru 5	Standard (See Card Group 3, Data Group BI)	1	1	Blade length in ft. (See Fig. 2)
						2	Blade mount eccentricity, e_x (ft) (See Fig. 2)
						3	Blade "rigid root" length e_y (ft) (See Fig. 2)
						4	Blade mount eccentricity, e_z (ft) (See Fig. 2)
						5	Steady state upwash angle (degrees)
3	1 or 2	6 (MAX)	1 thru 6	Standard (See Card Group 3, Data Group BI)	1	1 thru 6	Distances from blade root point to "mass points" of 1st 6 blade segments (ft).
					2	1 thru 4	Distances as above for segments 7 thru 10. Note; Omit 2nd card if No. of blade segments is 6 or less

BII-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
4 thru 19	1 or 2	6 (MAX)	1 thru 6	Standard	1	1 thru 6	Items, as described on the following pages, pertaining to 1st six blade segments
					2	1 thru 4	Same items as above for segments 7 thru 10. } Note; Same as on previous page.

		BII-3
GRP. NO.	ITEM DESCRIPTION	UNITS
4	Mass per unit length	slugs/ft
5	C.G. location aft of elastic axis	ft.
6	Mass moment of inertia per unit length about local chord axis (assumed to pass through elastic center)	slug-ft^2/ft
7	Mass moment of inertia per unit length about normal to chord axis passing through elastic center	slug-ft^2/ft
8	Average chord length over segment length	ft.
9	Aerodynamic center location ahead of quarter-chord at a representative section as ratio of average chord length	N.D.
10	Quarter-chord location ahead of elastic axis at a representative section as ratio of average chord length	N.D.
11	Lift curve slope	N.D.
12 13 14	Drag coefficient d_0 Drag coefficient d_1 Drag coefficient d_2 See Note #2, p. 40	N.D.
15a 15b 15c 15d	Lag components of four blade modes successively. Note: If less than 4 blade modes are involved, the items here must be accordingly limited.	ft.
16a 16b 16c 16d	Flap components of four blade modes in succession Note: As above.	ft.
17a 17b 17c 17d	Rate of increase with blade length of lag components of blade modes. Note: As for 15	N.D.
18a 18b 18c 18d	Rate of increase with blade length of flap components of blade modes. Note: As for 15.	N.D.
19a 19b 19c 19d	Twist components of four blade modes in succession. Note: As for 15.	Radians

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
20	1	3	1 thru 3	Standard	1	1	Rotor angular velocity (RPM)
						2	Pitch component of steady state hub teetered angle (degrees)
						3	Yaw component of steady state hub teetered angle (degrees)
21 thru 25	1 or 2	6 MAX	1 thru 6	Standard	1	1 thru 6	Items, as described below, pertaining to 1st six blade segments
					2	1 thru 4	Same items as above for segments 7 thru 10. Note: As for Grp. 3

GP.	DESCRIPTION	UNITS
21	Lag components (collective) of steady state blade displacements.	ft.
22	Flap components of above displacements.	ft.
23	Rate of increase with blade length of lag components in 21.	N.D.
24	Rate of increase with blade length of flap components in 22.	N.D.
25	Steady state twist angles (including geometric twist and collective pitch)	Degs

BII-5

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
26	4	4	1 thru 4	Standard	1	1 thru 4	Blade modal frequencies(rotating) in radians/sec.
					2	1 thru 4	Structural damping coefficients for the blade modes (N.D.)
					3	1 thru 4	Fractional critical viscous damping in the blade modes.
					4	1 only	Rotor RPM corresponding to the blade modal frequencies above (RPM)
27A	5	3	1 thru 3	Standard	1	1 thru 3	V0 Induced velocity components for 1st blade segment. Note: See Note #3 p. 40 for definition of symbols. Omit all cards if induced velocities are excluded i.e., Entry #14 on first card of Data Grp. BI is zero.
					2	1 thru 3	V1C
					3	1 thru 3	V1S
					4	1 thru 3	V2C
					5	1 thru 3	V2S
27B thru 27J	Repeat Card Group 27A for 2nd and subsequent blade segments.						

DATA GROUP BIII: Required only if a second rotor is present.

BIII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1 thru 26	Same items as in the correspondingly numbered card groups of Data Group BII.						Note: Omit if No. of Data Sets (entry no. 7 on Card 3 of Data Group A) is less than 2.
27A thru 27J	The correspondingly numbered card groups from Data Group BII are repeated here for the second rotor.						Note: Omit if induced velocities are not included; i.e. entry No. 14 on first card of Data Group BI is zero.

DATA GROUP BIV: Omit if rotor 1 is absent, i.e., Entry No. 1, Card no. 3 in Group 1 of Data Group BI is 2.

BIV-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	6	1 thur 6	Standard	1	1	X coordinate (A/C axes) of nacelle axis at its root in the airframe (ft.)
						2	Y coordinate corresp. to above (ft.)
						3	Z coordinate corresp. to above (ft.)
						4	"Tilt" angle of airframe component (e.g.wing) at nacelle root (degrees)
						5	"Tilt" angle of nacelle axis relative to airframe component at nacelle root (degrees).
						6	Number of nacelle "mass" points (10 max) Note: The last "mass" point must apply to the rotor hub and is considered massless. ANY MASS SPECIFIED FOR LAST MASS POINT WILL BE IGNORED. To account for a hub mass, the mass points should be specified such that the last two BOTH REPRESENT THE HUB POINT. The hub mass is then specified for the last but one mass point.

BIV-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION	
2	Var. 1 to 5	6 MAX	1 thru 6	Standard	1	1 thru 3	Coords. in rotor axes of mass point 1	For rotor coord. axes, see Fig. 3
						4 thru 6	Coords. in rotor axes of mass point 2.	
					2	1 thru 3	Coords. of mass point 3	
						4 thru 6	Coords. of mass point 4	
					3	1 thru 3	Coords. of mass point 5	**Note**: Limit no. of cards in accordance with no. of mass points
						4 thru 6	Coords. of mass point 6	
					4	1 thru 3	Coords. of mass point 7	
						4 thru 6	Coords. of mass point 8	
					5	1 thru 3	Coords. of mass point 9	
						4 thru 6	Coords. of mass point 10	
3a	Var. 1 to 10	6	1 thru 6	Standard	1	1 thru 3	Displacement components (rotor axes) of 1st elastic mode at 1st mass point(ft.)	**Note**: same as above
						4 thru 6	Rotation components(rotor axes) of 1st elastic mode at 1st mass point (radians)	
					2 thru 10	1 thru 3 4 thru 6	Same items as for card 1 but pertaining to 2nd, 3rd,....10th mass points successively	

BIV-3

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
3b 3c 3d 3e 3f	SAME	AS FOR	3a				Items specified in 3a for 1st elastic mode are repeated for 2nd, 3rd,......6th elastic modes as applicable.
4	Var. 1 to 10	4	1 thru 4	Standard	1	1	Mass at mass point 1 (SLUGS)
						2 3 4	Mass moments of inertia at mass point 1 about rotor coordinate axes. (SLUG-FT^2)
					2 thru 10	Repeat	Card 1 data for mass points 2 through 10 as applicable

DATA GROUP CI: Required for all runs.

CI-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
1	1	7	1 thru 7	Fixed point numbers in succ. fields of 5 cols. each starting from col. 1	1	1 thru 6	Indices pertaining to the following airframe components in order: - 1. Right Wing 2. Left Wing 3. Fuselage 4. Right Tail 5. Left Tail 6. Fin They define the presence or absence of the corresponding components in the system being analyzed. Enter 1: if component is present; 0: if component is absent.
						7	Index referring to airframe aerodynamics. Enter 1: if aerodynamics are to be included in analysis; 0: if aerodynamics are to be neglected in analysis
2	1	2	1 & 2	Standard	1	1 2	Reference semi-chord (ft.) Reference panel width (ft.) __Note__: This card must be eliminated if entry 7 on previous card is zero.

DATA GROUP CII: Omit if right wing is absent, i.e., Entry No. 1 on Card 1 of Data Group CI is zero. CII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY DESCRIPTION ENTRY NO.	ENTRY DESCRIPTION DESCRIPTION	
1	1	1	1	Fixed point right justified in cols 1-5	1	1	Number of panels (N.D.)	
2a	Var. 1 to 20	6	1 thru 6	Standard	1	1 thru 3	Displacement components (local axes) of 1st elastic mode at first panel (ft.)	For local axes, see Fig. 4
						4 thru 6	Rotation components (radians) of 1st elastic mode at 1st panel	
					2 thru 20	Same items as for card 1 but pertaining to panels 2 through 20 as applicable.		
2b 2c 2d 2e 2f	Same as for 2a						Items specified in 2a for 1st elastic mode are repeated for 2nd through 6th elastic modes as required.	
3	Var. 2 to 40	6 MAX.	1 thru 6	Standard	1	1 thru 3	Coordinates (aircraft axes) of panel reference point (i.e., pt. at which mode shapes are specified) for 1st panel (ft.)	
						4	Panel "TILT" angle (about A/C pitch axis) (Degrees)	
						5 & 6	1st 2 coordinates (local axes) of panel c.g. relative to panel ref.pt. (ft.)	

CII-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
					2	1	Third coordinate (local axes) of panel c.g. relative to panel ref. point (ft.)
					3 & 4	Same as	1 & 2 above but for panel no. 2
					5 & 6	Same as	1 & 2 above but for panel no. 3
					. . . .	. . . .	. . . .
					39 & 40	Same as	1 & 2 above but for panel no. 20
4	Var. 1 to 20	4	1 thru 4	Standard	1	1	Mass of Panel 1 (SLUGS)
						2 3 4	Mass moments of inertia of panel 1 about local axes passing through panel c.g.
					2 thru 20	Repeat card 1 data for panels 2 through 20 as applicable	
5	Var. 1 to 4	6 MAX.	1 thru 6	Standard	1	1 thru 6	Widths (ft.) of 1st 6 panels
					2	1 thru 6	Widths (ft.) of panels 7 thru 12 as applicable
					3	1 thru 6	Widths (ft.) of panels 13 thru 18 as applicable
					4	1 and 2	Widths (ft.) of panels 19 and 20 as applicable
							Note: As for Grp. 7. See Below

CII-3

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
6	Var. 1 to 4	6 MAX.	1 thru 6	Standard	1	1 thru 6	Semi-chord lengths (ft.) Panels 1 through 6
					2	1 thru 6	Semi-chord lengths (ft.) Panels 7 through 12
					3	1 thru 6	Semi-chord lengths (ft.) Panels 13 through 18
					4	1 and 2	Semi-chord lengths (ft.) Panels 19 and 20
							Note: As for Grp. 7 below.
7	Var. 1 to 4	6 MAX.	1 thru 6	Standard	1	1 thru 6	"ab" distances (ft.), Panels 1 through 6
					2	1 thru 6	"ab" distances (ft.), Panels 7 through 12
					3	1 thru 6	"ab" distances (ft.), Panels 13 through 18
						1 and 2	"ab" distances (ft.), Panels 19 and 20
							Note: All entry items in Groups 5, 6, and 7 should be omitted if airframe aerodynamics are not being considered in analysis, i.e. entry No. 7 on Card 1, Group CI is zero.

DATA GROUP CIII:	Required if left wing is present, i.e. entry number 2 on Card 1 of Data Group CI is 1.	The entry items described for Data Group CII are repeated for the left wing.
DATA GROUP CIV:	Required if fuselage is present; i.e., entry number 3 on Card 1 of Data Group CI is 1.	The entry items described for Data Group C-II under Card Groups 1 through 4 are repeated for the fuselage.
DATA GROUP CV:	Required if right tail is present; i.e., entry number 4 on Card 1 of Data Group CI is 1.	Entry items described for Data Group CII are repeated for right tail.
DATA GROUP CVI:	Required if left tail is present; i.e., entry number 5 on Card 1 of Data Group CI is 1.	As above for left tail.
DATA GROUP CVII:	Required if fin is present; i.e., entry number on Card 1 of Data Group CI is 1.	As above for the fin.

DATA GROUP CVIII: Omit if number of elastic modes (Entry No. 8 on Card 3 of Data Group A) is zero.

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	1	1	Fixed point right justified in 1st 5 cols.	1	1	Damping type selector Enter 1: if airframe damping is to be treated as viscous; 2: if it is to be treated as structural; or 3: if it is a combination of both types.
2	3	6	1 thru 6	Standard	1	1 thru 6	Modal frequencies (Radians/Sec) for the six elastic modes as applicable
					2	1 thru 6	Fractional critical viscous damping in elastic modes (N.D.)
					3	1 thru 6	Structural damping coefficients (N.D.)

DATA GROUP D: Omit if no landing gears are involved in analysis i.e., Entry No. 9 on Card 3 of Data Group A is zero.

D-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
1a	Var. 1 to 4	6	1 thru 6	Standard	1	1 thru 3	Displacement components (A/C axes) of 1st elastic mode at point of attachment in the airframe of Landing Gear 1 (ft.)
						4 thru 6	Rotation components corresponding to above (Radians).
					2, 3, 4	Same items as for Card 1 but relating to landing gears 2, 3, 4, as applicable.	
1b, 1c, 1d, 1e, 1f	Same as for 1a						Items specified in 1a for 1st elastic mode are repeated for modes 2, 3, 4, 5, 6 as applicable.
2	Var. 1 to 4	4	1 thru 4	Standard	1	1 thru 3	Coordinates (A/C axes) of landing gear 1 attachment point in airframe (ft.)
						4	Distance (ft.) of Gear 1 wheel mass location below attachment point in airframe
					2, 3, 4	Same items as for card 1 but relating to landing gears 2, 3, 4, as applicable.	

D-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION			
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION	
3	Var. 1 to 4	1	1	Standard	1	1	Wheel mass for landing gear 1	
					2, 3, 4	1	Wheel masses for gears 2, 3, 4, as required.	
4	Var. 1 to 4	4	1 thru 4	Standard	1	1 thru 4	Damping coefficients for Gear 1	See typ. gear represen-tation, Fig. 5
					2	1 thru 4	Damping coefficients for Gear 2	
					3	1 thru 4	Damping coefficients for Gear 3	
					4	1 thru 4	Damping coefficients for Gear 4 (lb-sec/ft. units)	
5	Var. 1 to 4	4	1 thru 4	Standard	1	1 thru 4	Stiffness coefficients for Gear 1	See typ. gear represen-tation, Fig. 5
					2	1 thru 4	Stiffness coefficients for Gear 2	
					3	1 thru 4	Stiffness coefficients for Gear 3	
					4	1 thru 4	Stiffness coefficients for Gear 4	

DATA GROUP E: Omit if airframe aerodynamics are not being considered in analysis, i.e., Entry No. 7 on Card 1, Group CI is zero.

E-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	5 MAX.	1 thru 5	Standard	1	1	"Sweepback" angle (degrees) of first airframe component (excluding fuselage) specified present in Data Group CI.
						2 3 4 5	"Sweepback" angles (degrees) of 2nd, 3rd, 4th, 5th airframe components (excluding fuselage) specified present in Data Group CI.
2	1	1	1	Standard	1	1	Reduced frequency

DATA GROUP FI: Required for multi-case runs under Looping Option 1 i.e., Entries 10 and 11 on Card 3, Data Group A are respectively 1 and 1.

FI-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION NO.	FIELD DESCRIPTION FORMAT	ENTRY DESCRIPTION CARD NO.	ENTRY NO.	DESCRIPTION
1	1	2	1 & 2	Fixed point right justified in Cols. 1-5 and Cols. 6-10	1	1	Program continuation/termination index: Enter 1: to continue, 0: to terminate after this case
						2	Induced velocity index: 1 = read new values 0 = retain values from previous case
2	1	5	1 thru 5	Standard	1	1	Air density in slugs/ft^3
						2	Speed of sound ft/sec
						3	A/C speed component parallel to X axis, ft/sec
						4	A/C speed component parallel to Y axis, ft/sec
						5	A/C speed component parallel to Z axis, ft/sec
3A thru 3J	As in Data Group BII, Card Groups 27A thru 27J						Omit all card groups if induced velocity index above is zero.
4A thru 4J	As in Data Group BIII, Card Groups 27A thru 27J						Omit if second rotor is absent; Omit all card groups if induced velocity index above is zero.

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DATA GROUP FIII: Required for multi-case runs under Looping Option 3 i.e., Entries 10 and 11 on Card 3, Data Group A are respectively 3 and 1.

FIII-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	2	1 & 2	Fixed point right justified in Cols. 1-5 and Cols. 6-10	1	1 2	Program continuation/termination index: Enter 1: to continue 0: to terminate after this case Induced velocity index: 1 = read new values 0 = retain values from previous case
2	1	5	1 thru 5	Standard	1	1 2 3 4 5	As for data group FI, Card Grp. 2
3	1	3	1 thru 3	Standard	1	1 2 3	As for data Group FII, Card Grp. 2
4 thru 8	1 or 2	6 MAX.	1 thru 6	Standard	1 2	1 thru 6 1 thru 4	As for data group FII, Card groups 3 through 7 respectively.
9A thru 9J	As in Data Group BII, Card Groups 27A through 27J						Omit all card groups if induced velocity index above is zero.
10 thru 14	1 or 2	6 MAX.	1 thru 6	Standard	1 2	1 thru 6 1 thru 4	As for data group FII, Card groups 9 through 13 respectively.

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
5	1	1	1	Standard	1	1	Reduced frequency for this case Note: Omit if airframe aerodynamics are being neglected, i.e. Entry 7, Card Group 1 of Data Group CI is zero.

DATA GROUP FII: Required for multi-case runs under Looping Option 2 i.e., Entries 10 and 11 on Card 3, Data Group A are respectively 2 and 1.

FII-1

<table>
<tr><th rowspan="2">CARD GRP. NO.</th><th rowspan="2">NO. OF CARDS</th><th rowspan="2">NO. OF ENTRY FIELDS PER CARD</th><th colspan="2">FIELD DESCRIPTION</th><th colspan="3">ENTRY DESCRIPTION</th></tr>
<tr><th>NO.</th><th>FORMAT</th><th>CARD NO.</th><th>ENTRY NO.</th><th>DESCRIPTION</th></tr>
<tr><td>1</td><td>1</td><td>2</td><td>1 & 2</td><td>Fixed point right justified in Cols. 1-5 and Cols. 6-10.</td><td>1</td><td>1

2</td><td>Program continuation/termination index: Enter 1: to continue
0: to terminate after this case
Induced velocity index:
1 = read new values
0 = retain values from previous case</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>1 thru 3</td><td>Standard</td><td>1</td><td>1
2

3</td><td>Rotor angular velocity (RPM)
Pitch component of hub teetered angle (°)
Yaw component of hub teetered angle(°)</td></tr>
<tr><td>3 thru 7</td><td>1 or 2</td><td>6 MAX.</td><td>1 thru 6</td><td>Standard</td><td>1

2</td><td>1 thru 6

1 thru 4</td><td>Items, as described below, pertaining to 1st six blade segments.
Same items as above for segments 7 through 10 as necessary.
<table><tr><th>GP</th><th>DESCRIPTION</th><th>UNITS</th></tr><tr><td>3</td><td>Lag components (collective) of steady state blade displacements.</td><td>ft.</td></tr><tr><td>4</td><td>Flap components of above displacements.</td><td>ft.</td></tr><tr><td>5</td><td>Rate of increase with blade length of lag components 3.</td><td>N.D.</td></tr><tr><td>6</td><td>Rate of increase with blade length of flap components 4.</td><td>N.D.</td></tr><tr><td>7</td><td>Steady state twist angles (including geometric twist and collective pitch).</td><td>Degs</td></tr></table></td></tr>
</table>

FII-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO	DESCRIPTION
8A thru 8J	As in Data Group BII, Card Groups 27A through 27J						Omit all card groups if induced velocity index above is zero.
9 thru 13	1 or 2	6 MAX.	1 thru 6	Standard	1	1 thru 6	As described above for Groups 3 through 7 but pertaining to second rotor data set. Note: These groups must be eliminated if number of rotor data sets (Entry No. 7, Card Group 3 of Data Group A) is less than 2.
14A thru 14J	As in Data Group BIII, Card Groups 27A through 27J						Omit if second rotor is absent or induced velocity index is zero.
15	1	1	1	Standard	1	1	Reduced frequency for this case. Note: Omit if airframe aerodynamics are being neglected, i.e. Entry 7, Card Group 1 of Data Group CI is zero.

FIII-2

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
15A thru 15J	As in Data Group BIII, Card Groups 27A through 27J						Omit if second rotor is absent or induced velocity index above is zero.
16	1	1	1	Standard	1	1	Reduced frequency for this case. Note: Omit if airframe aerodynamics are being neglected i.e., Entry 7, Card Group 1 of Data Group CI is zero.

DATA GROUP FIV: Required for multi-case runs under Looping Option 4 i.e., Entries 10 and 11 on Card 3, Data Group A are respectively 4 and 1.

FIV-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	1	1	Fixed point right justified in cols 1-5	1	1	Program continuation/termination index Enter 1: to continue 0: to terminate after this case
2	3	6	1 thru 6	Standard	1 2 3	1 thru 6 1 thru 6 1 thru 6	Modal frequencies (radians/sec) for the six elastic modes as applicable Fractional critical viscous damping in elastic modes (N.D.) Structural damping coefficients (N.D.)
3	1	1	1	Standard	1	1	Reduced frequency for this case. Note: Omit if airframe aerodynamics are being neglected, i.e. Entry 7, Card Group 1 of Data Group CI is zero.

DATA GROUP FV: Required for multi-case runs under Looping Option 5 i.e., Entries 10 and 11 on Card 3, Data Group A are respectively 5 and 1.

FV-1

CARD GRP. NO.	NO. OF CARDS	NO. OF ENTRY FIELDS PER CARD	FIELD DESCRIPTION		ENTRY DESCRIPTION		
			NO.	FORMAT	CARD NO.	ENTRY NO.	DESCRIPTION
1	1	1	1	Fixed point right justified in cols. 1-5	1	1	Program continuation/termination index Enter 1: to continue, 0: to terminate after this case
2 thru 6							As for Data Group D, Card Groups 1 through 5 respectively.
7	1	1	1	Standard	1	1	Reduced frequency for this case. Note: Omit if airframe aerodynamics are being ignored, i.e., if Entry 7, Card Group 1 of Data Group CI is zero.

NOTES:-

1. Sign Convention for Rigid Modes is:

   Longitudinal translation positive FORWARD
   Lateral translation positive to the RIGHT
   Vertical translation positive DOWNWARD
   Roll translation positive RIGHT SIDE DOWN
   Pitch translation positive NOSE UP
   Yaw translation positive RIGHT SIDE BACKWARD

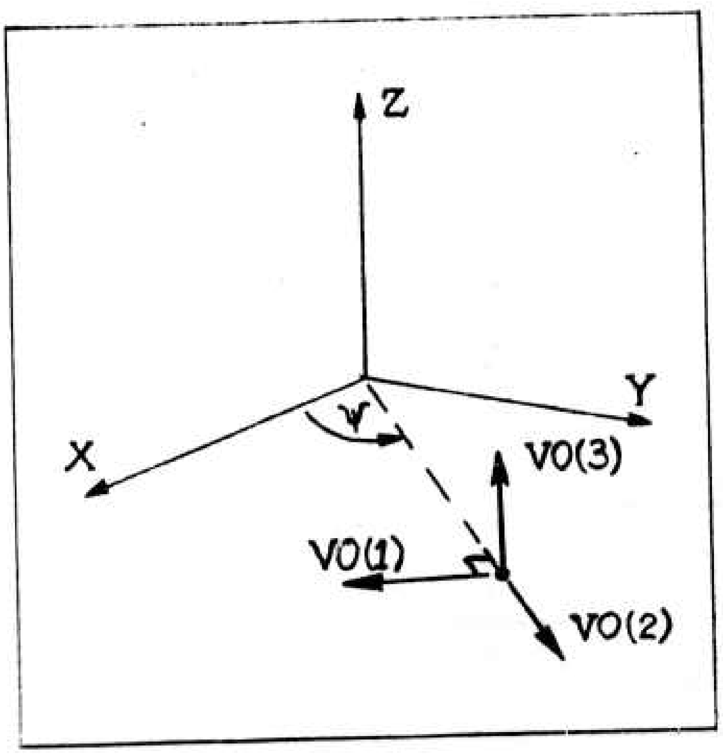
2. Drag coefficients d_0, d_1, d_2 are components of the Net Drag coefficient (C_D) according to the formula

$$C_D = d_0 + d_1 \alpha + d_2 \alpha^2$$

   where α represents aerodynamic angle of attack.

3. The induced velocity vector $\{VI\}$ at a given blade segment is represented by a truncated harmonic series of the azimuth angle ψ :

$$\{VI\} = \{VO\} + \{V1C\}\cos\psi + \{V1S\}\sin\psi + \{V2C\}\cos 2\psi + \{V2S\}\sin 2\psi$$



Each of the above coefficient vectors is made up of a tangential and a radial component each parallel to the hub-disc-plane, and a normal component as illustrated in the adjoining sketch for $\{VO\}$

PROGRAM OUTPUT

The program generates a printed output of several items which fall into three major classes as described below.

1. Basic Data: A number of selected input data and program options are printed out with adequate descriptive headings and/or other qualifications to help identify them.

2. Coefficient Matrices: Contributions to the coefficient matrices by the various subsystems and the final matrices resulting therefrom are optionally printed out by rows with row number identifications and a descriptive heading for each complete matrix. The rows and columns are associated with generalized forces and displacements, velocities or accelerations corresponding to the system freedoms ordered in the following sequence:

   (i) System rigid body freedoms, if any;

   (ii) Airframe elastic mode freedoms, if any;

   (iii) Teetering freedoms in pitch, yaw and roll for the first rotor, as present;

   (iv) Blade mode freedoms for the first rotor, as present;

   (v) Teetering freedoms for the second rotor, if any;

   (vi) Blade mode freedoms for the second rotor, as present; and

   (vii) Landing gear freedoms, if any.

   The blade mode freedoms are arranged with the collective freedoms of all modes occurring first, followed by the cyclic yaw and finally the cyclic pitch freedoms.

3. Problem Solutions: Both the vibration and flutter solutions for a given case consist of a table of complex roots of the matrix equations and their related physical quantities, and optionally the corresponding vectors.

The physical quantities related to the roots include frequencies, a measure of damping (defined differently for the two solution types), and in the case of the flutter solution, the flutter velocities.

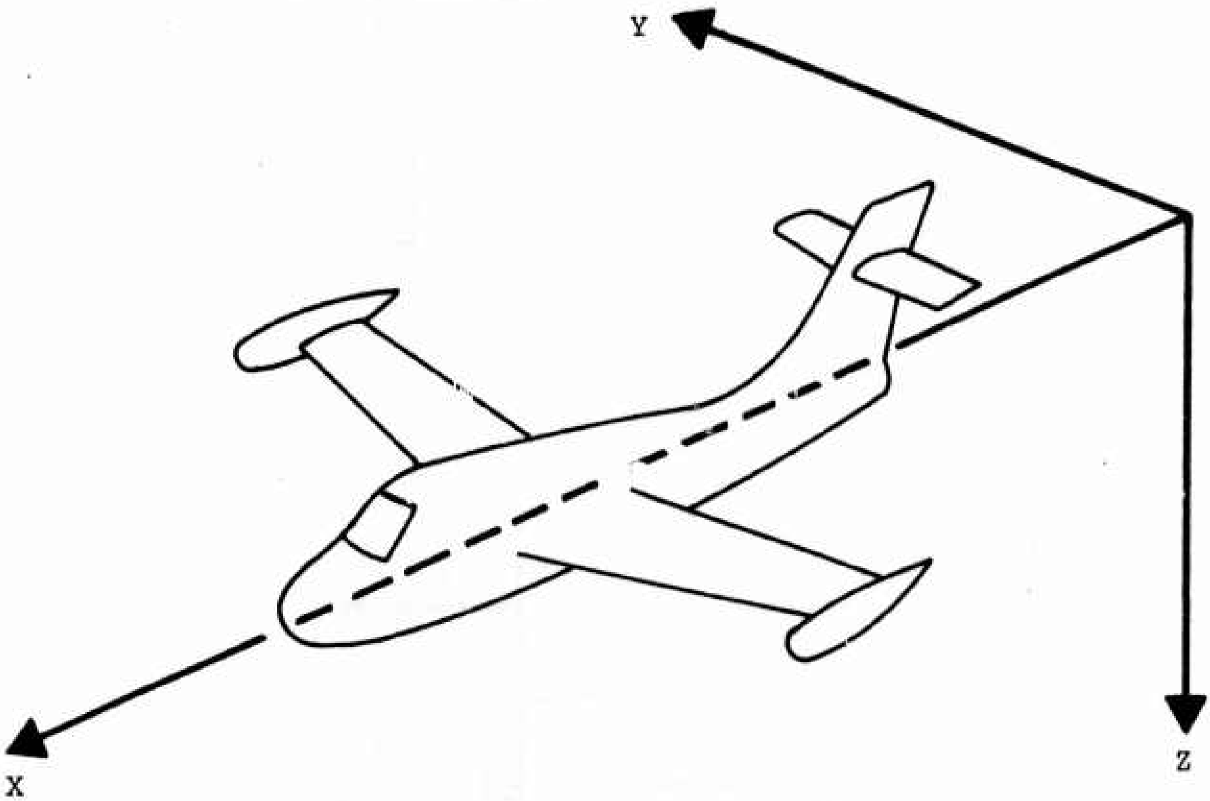


Figure 1. Aircraft Coordinate Axes (Fixed-Coordinate System)

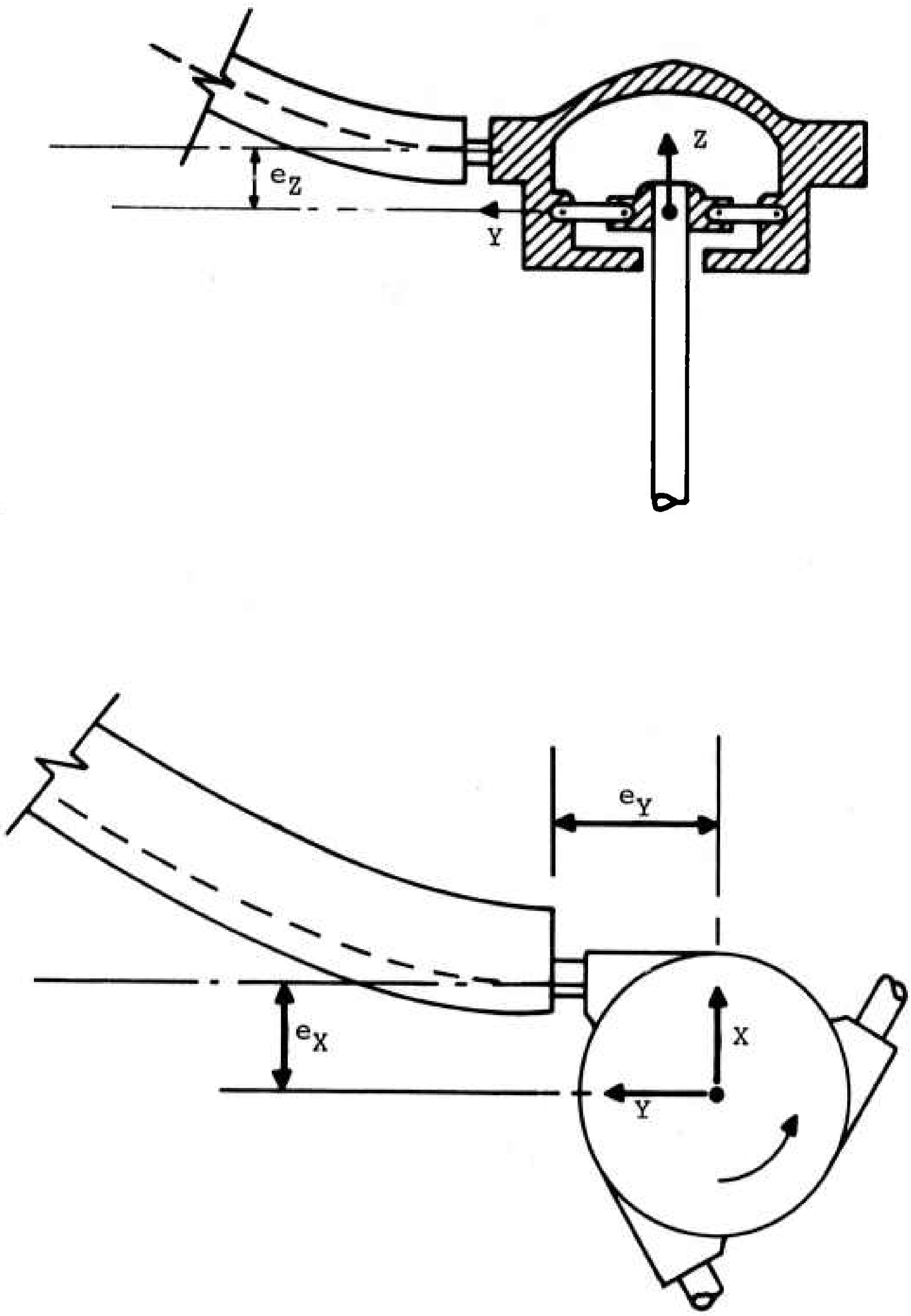


Figure 2. Schematic Diagram of Rotor Hub Showing Blade Mount Eccentricities

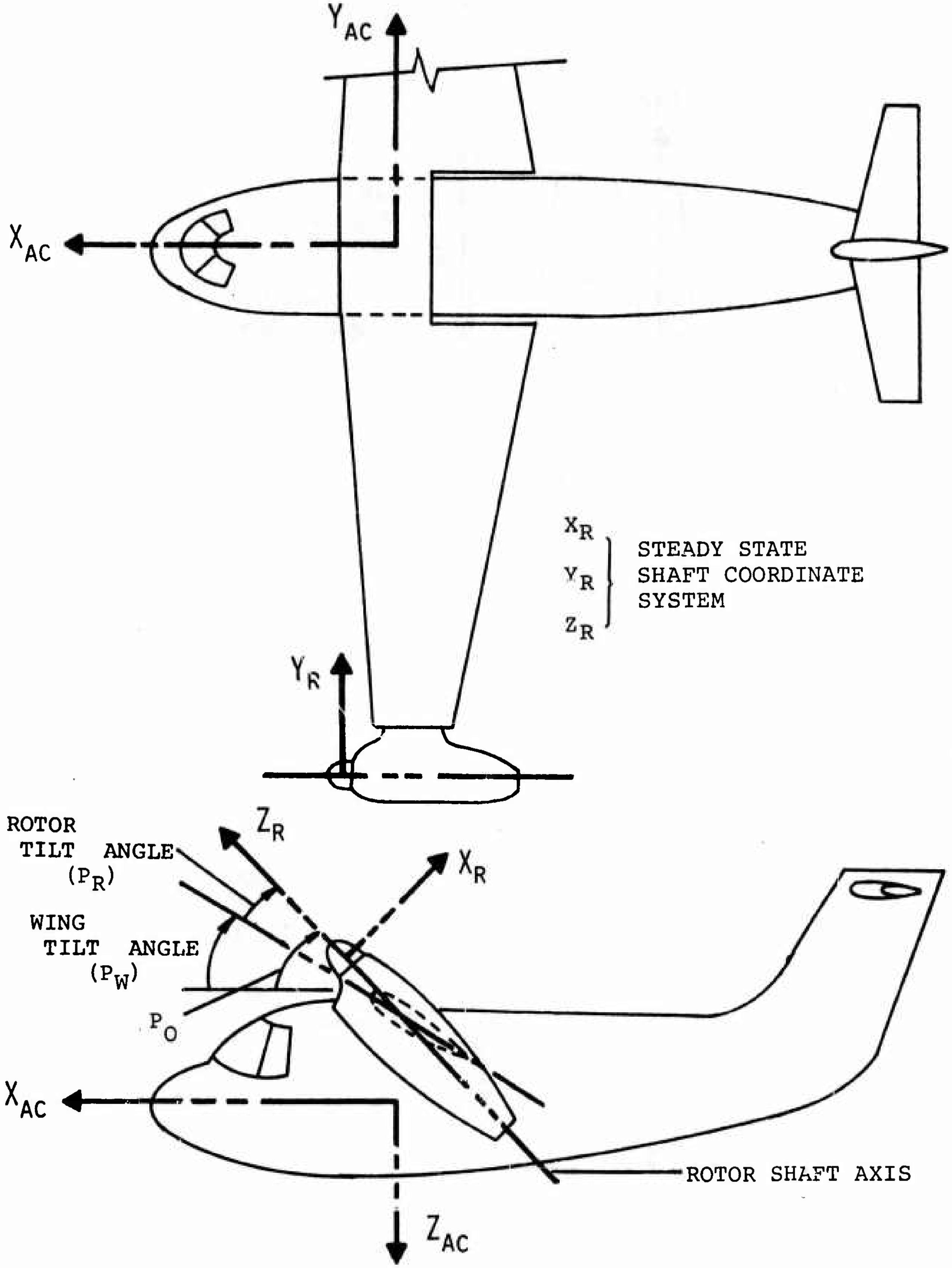


Figure 3. Rotor and Aircraft Coordinate Axes

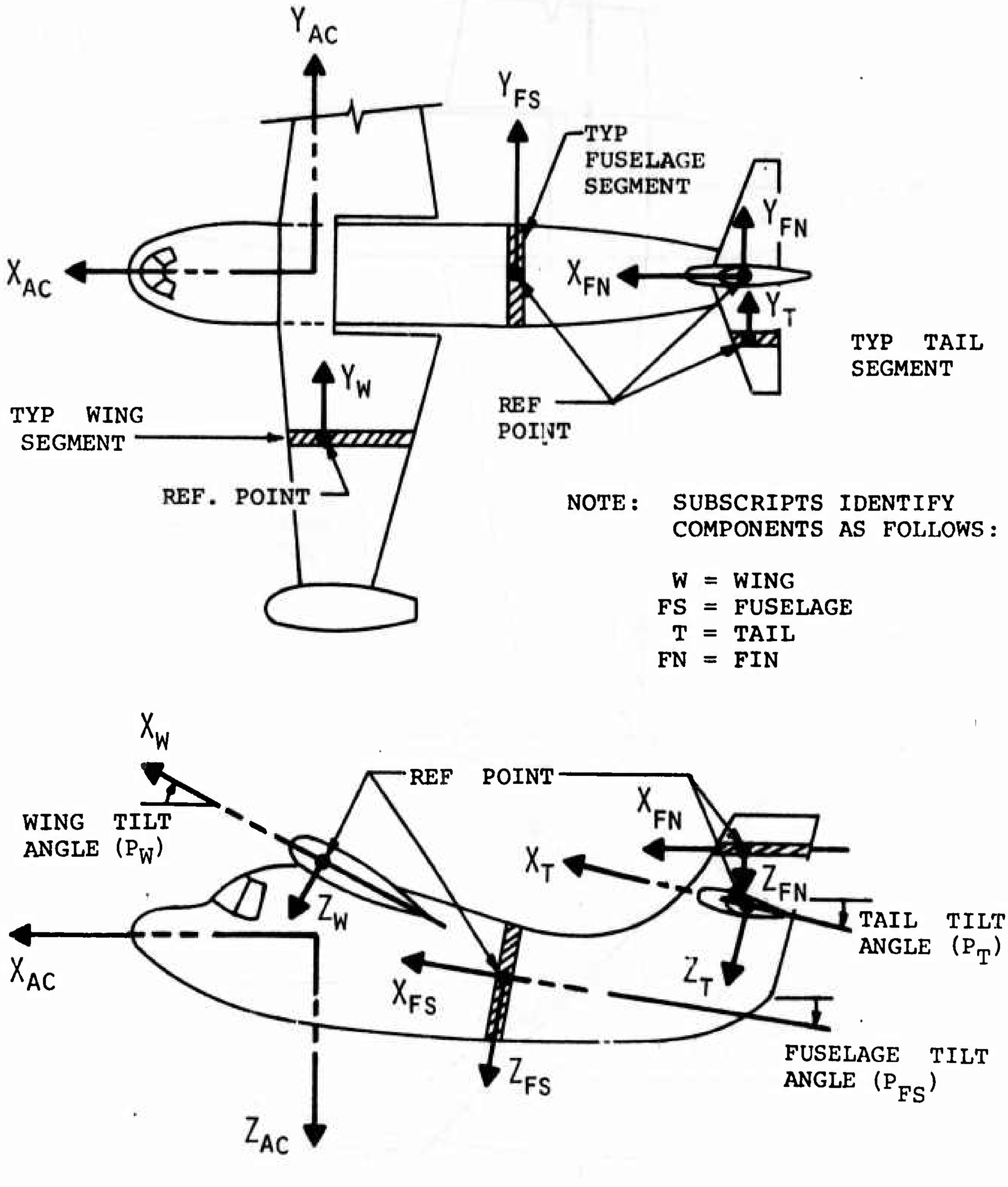


Figure 4. Local Coordinate Axes for Typical Segment of Various Airframe Components

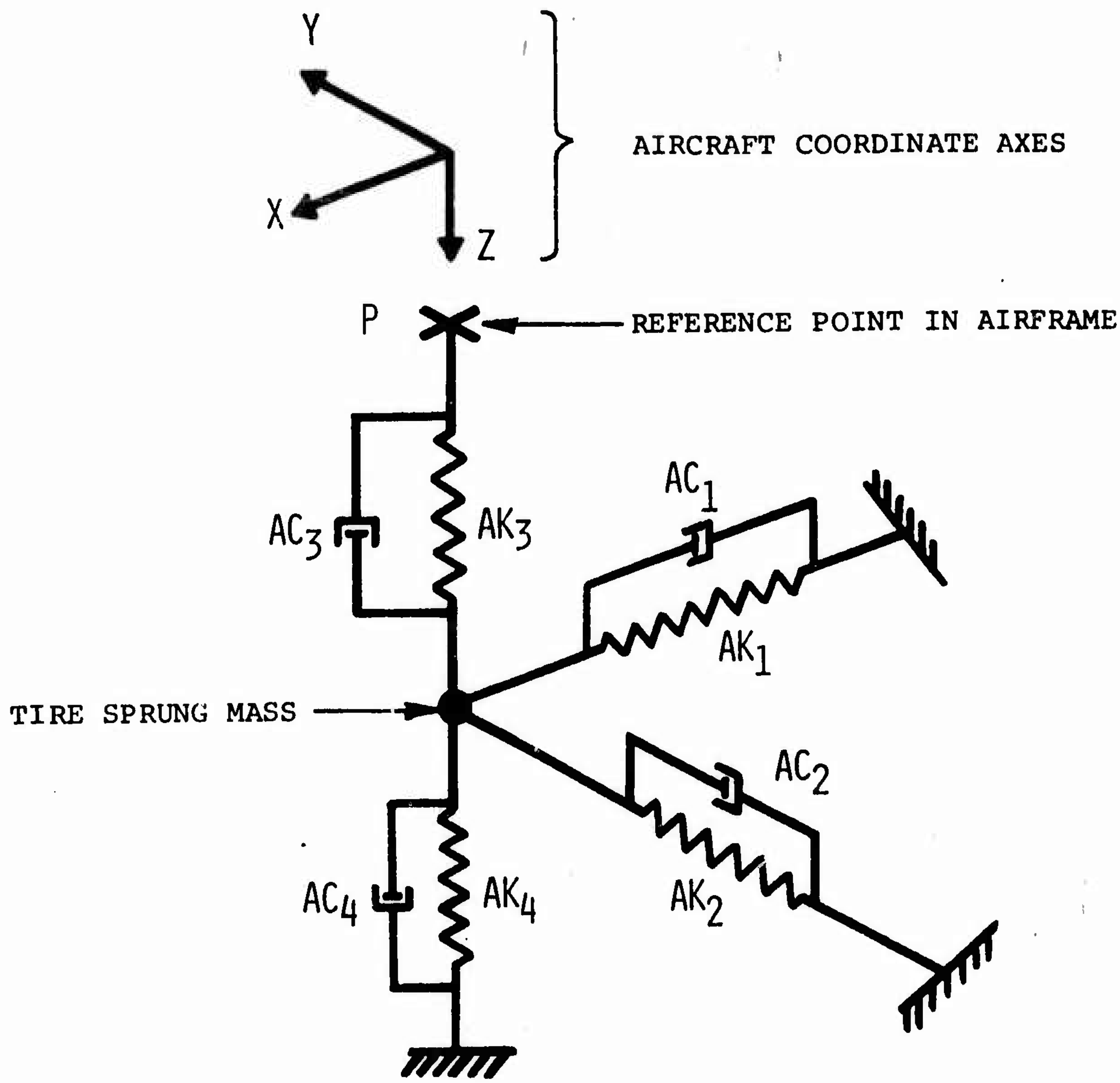


Figure 5. Typical Landing Gear Representation

SAMPLE PROBLEM

INPUT DATA

See following sheets.

C-39 INPUT DATA

SHEET 1 of 6

Data Gp	Card Gp	Card No.																
A	1	1	SAMPLE PROBLEM															
A	2	1	0.															
A	3	1	0	0	0	0	0	0	1	0	0	2	1	1	1	0	1	0
BI	1	1	2	1	1	1	1	1	1	0	0	0	0	0	0			
BI	1	2	0	0	0	0												
BI	1	3	1	2	1	2	1	1	1									
BI	2	1	LEFT OUTBOARD AT WING TIP															
BI	3	1	.002378		1116.			140.										
BI	4	1	0	1														
BII	1	1	4	10														
BII	2	1	2.732															
BII	3	1	.1366		.410			.683		.1957			1.23			1.503		
BII	3	2	1.777		2.05			2.323		2.597								
BII	4	1	0.		.00612			.005167		.00508			.00491			.00491		
BII	4	2	.00491		.00491			.00491		.00491								
BII	5	1	0.															
BII	5	2	0.															
BII	6	1	0.															
BII	6	2	0.															
BII	7	1	0															
BII	7	2	0															
BII	8	1	0		.2133			.2133		.2133			.2133			.2133		
BII	8	2	.2133		.2133			.2133		.2133								
BII	9	1	0															
BII	9	2	0.															
BII	10	1	0.															
BII	10	2	0.															
BII	11	1	5.73		5.73			5.73		5.73			5.73			5.73		

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SHEET 2 of 6

Data Gp	Card Gp	Card No.						
BII	11	2	5.73	5.73	5.73	5.73		
BII	12	1	0.					
BII	12	2	0.					
BII	13	1	0.					
BII	13	2	0.					
BII	14	1	0.					
BII	14	2	0.					
BII	15a	1	0.	-.007	-.0612	-.157	-.271	-.395
BII	15a	2	-.526	-.659	-.792	-.931		
BII	15b	1	0.	.001	.007	.018	.024	.025
BII	15b	2	.025	.0125	.025	.025		
BII	16a	1	0.	.0002	.002	.007	.003	-.006
BII	16a	2	-.017	-.027	-.0315	-.041		
BII	16b	1	0.	-.006	-.0510	.124	-.229	-.354
BII	16b	2	-.493	-.638	-.7815	.930		
BII	17a	1	0.	-.049	-.2815	.392	-.435	-.468
BII	17a	2	-.483	-.494	-.4918	.498		
BII	17b	1	0.	.007	.003	.037	.007	.004
BII	17b	2	0.					
BII	18a	1	0.	.004	.015	.007	-.089	-.040
BII	18a	2	-.037	-.033	-.026	-.018		
BII	18b	1	0.	-.090	-.2213	-.322	-.428	-.487
BII	18b	2	-.523	-.538	-.5314	-.520		
BII	19a	1	0.					
BII	19a	2	0.					
BII	19b	1	0.					
BII	19b	2	0.					
BII	20	1	600.					

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SHEET 3 of 6

Data Gp	Card Gp	Card No.	1	14	27	40	53	66	79
BII	21	1	0.						
BII	21	2	0.						
BII	22	1	0.						
BII	22	2	0.						
BII	23	1	0.						
BII	23	2	0.						
BII	24	1	0.						
BII	24	2	0.						
BII	25	1	0.	63.21	61.71	52.91	55.91	52.96	
BII	25	2	50.11	47.21	44.21	41.21			
BII	26	1	57.60	86.92					
BII	26	2	0.						
BII	26	3	.005	.005					
BII	26	4	600.						
BIV	1	1	-.111	-3.4	0.	0	0.	2.	
BIV	2	1	0.	0.	.667	0	0.	.806	
BIV	3a	1	.67481						
BIV	3a	2	.67459						
BIV	3b	1	.364				.6544		
BIV	3b	2	.455				.6544		
BIV	3c	1		-.4125	-1.0	.850			
BIV	3c	2		-.5213	-1.0	.850			
BIV	4	1	.137	.203	.203	.0203			
BIV	4	2	0.						
CI	1	1	0 1	0 0 0	0 0				
CIII	1	1	6						
CIII	2a	1			-.0126				
CIII	2a	2			-.045				

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SHEET 4 of 6

Data Gp	Card Gp	Card No.	1	11	21	31	41	51	61	71
CIII	2a	3				-.1721				
CIII	2a	4				-.4379				
CIII	2a	5				-.5666				
CIII	2a	6				-.6748				
CIII	2b	1						.0545		
CIII	2b	2						.1057		
CIII	2b	3						.2331		
CIII	2b	4						.4391		
CIII	2b	5						.5572		
CIII	2b	6						.6544		
CIII	2c	1	-.0221						-.118	
CIII	2c	2	-.078						-.205	
CIII	2c	3	-.2739						-.276	
CIII	2c	4	-.6411						-.418	
CIII	2c	5	-.911						-.550	
CIII	2c	6	-1.0						-.850	
CIII	3	1			-.1458					
CIII	3	2	0.							
CIII	3	3			-.1875					
CIII	3	4	0.							
CIII	3	5			-1.708					
CIII	3	6	0.							
CIII	3	7			-2.75					
CIII	3	8	0.							
CIII	3	9			-3.167					
CIII	3	10	0.							
CIII	3	11			-3.394					
CIII	3	12	0.							

C-39 INPUT DATA

SHEET 5 of 6

Data Gp	Card Gp	Card No.						
CIII	4	1	.0572	.01007	.00711	.0007		
CIII	4	2	.0530	.01013	.01312	.0013		
CIII	4	3	.1071	.0107.	.0174	.002.		
CIII	4	4	.13	.01015	.0146	.0015		
CIII	4	5	.0576	.01005	.0063	.0005		
CIII	4	6	0.					
CVIII	1	1	1					
CVIII	2	1	48.78	68.46	89.19			
CVIII	2	2	.02	.02	.02			
CVIII	2	3	0.					
FII	1	1	1					
FII	2	1	800.					
FII	3	1	0.					
FII	3	2	0.					
FII	4	1	0.					
FII	4	2	0.					
FII	5	1	0.					
FII	5	2	0.					
FII	6	1	0.					
FII	6	2	0.					
FII	7	1	0.	55.01	53.51	50.71	47.71	44.76
FII	7	2	41.91	39.01	36.01	33.01		
FII	1	1	1					
FII	2	1	1000.					
FII	3	1	0.					
FII	3	2	0.					
FII	4	1	0.					
FII	4	2	0.					

C-39 INPUT DATA

SHEET 6 of 6

Data Gp	Card Gp	Card No.	1–13	14–26	27–39	40–52	53–65	66–78	79–80
FII	5	1	0.						
FII	5	2	0.						
FII	6	1	0.						
FII	6	2	0.						
FII	7	1	0.	49.04	47.54	44.74	41.74	32.79	
FII	7	2	35.94	33.04	30.04	27.04			
FII	1	1	0						
FII	2	1	1200.						
FII	3	1	0.						
FII	3	2	0.						
FII	4	1	0.						
FII	4	2	0.						
FII	5	1	0.						
FII	5	2	0.						
FII	6	1	0.						
FII	6	2	0.						
FII	7	1	0.	44.93	43.38	40.54	37.53	34.58	
FII	7	2	31.73	28.93	25.83	22.83			

PROGRAM OUTPUT

See following sheets.

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

RIGID MODE FREEDOMS

LONGITUDINAL TRANSLATION (POS. FORWARD)	DELETED
LATERAL TRANSLATION (POS. TO RIGHT)	DELETED
VERTICAL TRANSLATION (POS. DOWNWARD)	DELETED
ROLL (POS. RIGHT SIDE DOWN)	DELETED
PITCH (POS. NOSE UP)	DELETED
YAW (POS. NOSE TO THE RIGHT)	DELETED

RIGID MODE SHAPES

0.0	0.0	0.0	0.0	0.0	0.0

NO. OF ELASTIC MODES = 3

NO. OF LANDING GEARS = 0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

BLADE MODE FREEDOMS

BLADE 1ST. MODE, COLLECTIVE	RETAINED
BLADE 1ST. MODE, CYCLIC YAW	RETAINED
BLADE 1ST. MODE, CYCLIC PITCH	RETAINED
BLADE 2ND. MODE, COLLECTIVE	RETAINED
BLADE 2ND. MODE, CYCLIC YAW	RETAINED
BLADE 2ND. MODE, CYCLIC PITCH	RETAINED
BLADE 3RD. MODE, COLLECTIVE	DELETED
BLADE 3RD. MODE, CYCLIC YAW	DELETED
BLADE 3RD. MODE, CYCLIC PITCH	DELETED
BLADE 4TH. MODE, COLLECTIVE	DELETED
BLADE 4TH. MODE, CYCLIC YAW	DELETED
BLADE 4TH. MODE, CYCLIC PITCH	DELETED

```
C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

AIR DENSITY            0.002378 SLUGS/CU.FT.

SPEED OF SOUND    1116.000     FT./SEC.

AIRSPEED COMPONENTS
      VX             140.000     FT./SEC.
      VY               0.0       FT./SEC.
      VZ               0.0       FT./SEC.

ROTOR 1      LEFT OUTBOARD AT WING TIP                    OPERATIVE
```

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

BLADE DATA FOR ROTOR 1

NO. OF BLADES= 4

BLADE LENGTH= 2.733 FT.

BLADE ECCENTRICITIES AT HUB

ECCX=	0.0	FT.
ECCY=	0.0	FT.
ECCZ=	0.0	FT.

BLADE GEOMETRY

SEGMENT	R(FT.)	EX(FT.)	LAMBDA A	LAMBDA F	C(FT.)
1	0.137	0.0	0.0	0.0	0.0
2	0.410	0.0	0.0	0.0	0.213
3	0.683	0.0	0.0	0.0	0.213
4	0.957	0.0	0.0	0.0	0.213
5	1.230	0.0	0.0	0.0	0.213
6	1.503	0.0	0.0	0.0	0.213
7	1.777	0.0	0.0	0.0	0.213
8	2.050	0.0	0.0	0.0	0.213
9	2.323	0.0	0.0	0.0	0.213
10	2.597	0.0	0.0	0.0	0.213

BLADE INERTIAS AND LIFT CURVE SLOPES

SEGMENT	M (SLUGS/FT.)	IX (SLUGS/FT.)	IZ (SLUGS/FT.)	D CL/ D ALPHA
1	0.0	0.0	0.0	5.730
2	0.006	0.0	0.0	5.730
3	0.006	0.0	0.0	5.730
4	0.005	0.0	0.0	5.730
5	0.005	0.0	0.0	5.730
6	0.005	0.0	0.0	5.730
7	0.005	0.0	0.0	5.730
8	0.005	0.0	0.0	5.730
9	0.005	0.0	0.0	5.730
10	0.005	0.0	0.0	5.730

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

BLADE MODE SHAPES FOR ROTOR 1

MODE 1

LAG(FT.)	LAG GRADIENT	FLAP(FT.)	FLAP GRADIENT	TWIST(RAD.)
0.0	0.0	0.0	0.0	0.0
-0.007	-0.099	0.000	0.004	0.0
-0.062	-0.285	0.002	0.015	0.0
-0.157	-0.392	0.007	0.007	0.0
-0.271	-0.435	0.003	-0.029	0.0
-0.395	-0.468	-0.006	-0.040	0.0
-0.526	-0.433	-0.017	-0.037	0.0
-0.659	-0.494	-0.027	-0.033	0.0
-0.792	-0.498	-0.035	-0.026	0.0
-0.931	-0.498	-0.041	-0.018	0.0

MODE 2

LAG(FT.)	LAG GRADIENT	FLAP(FT.)	FLAP GRADIENT	TWIST(RAD.)
0.0	0.0	0.0	0.0	0.0
0.001	0.007	-0.006	-0.080	0.0
0.007	0.003	-0.050	-0.223	0.0
0.018	0.037	-0.124	-0.322	0.0
0.024	0.007	-0.228	-0.428	0.0
0.025	0.004	-0.354	-0.487	0.0
0.025	0.0	-0.493	-0.523	0.0
0.025	0.0	-0.638	-0.538	0.0
0.025	0.0	-0.785	-0.534	0.0
0.025	0.0	-0.930	-0.520	0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ANGULAR SPEED FOR ROTOR 1 600.000 RPM, CLOCKWISE

STEADY STATE DEFLECTIONS FOR ROTOR 1

HUB TEETER ANGLES(DEG.)

PITCH	0.0
YAW	0.0

BLADE DEFLECTIONS

LAG(FT.)	LAG GRADIENT	FLAP(FT.)	FLAP GRADIENT	PITCH(DEG.)
0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	63.210
0.0	0.0	0.0	0.0	61.710
0.0	0.0	0.0	0.0	58.910
0.0	0.0	0.0	0.0	55.910
0.0	0.0	0.0	0.0	52.960
0.0	0.0	0.0	0.0	50.110
0.0	0.0	0.0	0.0	47.210
0.0	0.0	0.0	0.0	44.210
0.0	0.0	0.0	0.0	41.210

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

BLADE MODAL FREQUENCIES AND DAMPING FACTORS FOR ROTOR 1

MODE	FREQUENCY (RAD./SEC.)	VISCOUS DAMPING	STRUCTURAL DAMPING	REF. ANGULAR SPEED (RPM)
1	57.600	0.005	0.0	600.000
2	86.920	0.005	0.0	600.000

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

NACELLE NO. 1 PARAMETERS

COORDS. OF REF. POINT ON NACELLE AXIS

X(FT.)	Y(FT.)	Z(FT.)
-0.111000E 00	-0.340000E 01	0.0

TILT ANGLES AT REF. POINT

0.0 0.0

NO. OF SECTIONS = 2

MASS POINT LOCATIONS ON AXIS RELATIVE TO REF. POINT (POS. FORWARD OF REF. POINT)

0.0 0.0 0.667000E 00 0.0 0.0

0.800000E 00

ELASTIC MODE SHAPES

0.674800E 00	0.0	0.0	0.0	0.0	0.0
0.674800E 00	0.0	0.0	0.0	0.0	0.0
0.364000E 00	0.0	0.0	0.0	0.654400E 00	0.0
0.455000E 00	0.0	0.0	0.0	0.654400E 00	0.0
0.0	-0.412500E 00	-0.100000E 01	0.850000E 00	0.0	0.0
0.0	-0.521300E 00	-0.100000E 01	0.850000E 00	0.0	0.0

MASS (SLUGS) MASS MOMENTS OF INERTIA (SLUGS-FT.**2)

0.137000E 00	0.203000E 00	0.203000E 00	0.203000E-01
0.0	0.0	0.0	0.0

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR INERTIA DERIVATIVES

ROW 1

0.497472E-01	0.0	0.0	0.0	0.0	0.0
0.0	0.0	-0.102797E-01	0.473879E-03	0.0	0.0

ROW 2

0.0	0.497472E-01	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	-0.102797E-01	0.473879E-03

ROW 3

0.0	0.0	0.497472E-01	0.0	0.0	0.0
-0.612019E-03	-0.145184E-01	0.0	0.0	0.0	0.0

ROW 4						
	0.0	0.0	0.0	0.673447E-01	0.0	0.0
	0.0	0.0	-0.733135E-03	-0.200475E-01	0.0	0.0
ROW 5						
	0.0	0.0	0.0	0.0	0.673447E-01	0.0
	0.0	0.0	0.0	0.0	-0.733135E-03	-0.200475E-01
ROW 6						
	0.0	0.0	0.0	0.0	0.0	0.134689E 00
	0.415744E-01	-0.166479E-02	0.0	0.0	0.0	0.0
ROW 7						
	0.0	0.0	-0.612019E-03	0.0	0.0	0.415744E-01
	0.134034E-01	0.222237E-06	0.0	0.0	0.0	0.0
ROW 8						
	0.0	0.0	-0.195184E-01	0.0	0.0	-0.166479E-02
	0.222237E-06	0.126742E-01	0.0	0.0	0.0	0.0
ROW 9						
	-0.102797E-01	0.0	0.0	-0.733135E-03	0.0	0.0
	0.0	0.0	0.670169E-02	0.111116E-06	0.0	0.0
ROW 10						
	0.473679E-03	0.0	0.0	-0.200475E-01	0.0	0.0
	0.0	0.0	0.111118E-06	0.633712E-02	0.0	0.0

```
ROW 11
   0.0           -0.102797E-01   0.0            0.0            -0.733135E-03   0.0
   0.0            0.0            0.0            0.0             0.670169E-02   0.111118E-06
ROW 12
   0.0            0.473879E-03   0.0            0.0            -0.200475E-01   0.0
   0.0            0.0            0.0            0.0             0.111118E-06   0.633712E-02

   C39 FINITE DEFLECTION STABILITY ANALYSIS

   SAMPLE PROBLEM

   ROTOR DAMPING DERIVATIVES

ROW  1
   0.799349E 00   0.0            0.0            0.104535E 01   0.0            0.0
   0.0            0.0           -0.319896E 00  -0.265400E 00   0.0            0.0
ROW  2
   0.0            0.799349E 00   0.0            0.0             0.104535E 01   0.0
   0.0            0.0            0.0            0.0            -0.319896E 00  -0.265400E 00
ROW  3
   0.0            0.0            0.876218E 00   0.0             0.0           -0.167567E 01
  -0.550802E 00  -0.492519E 00   0.0            0.0             0.0            0.0
```

ROW 4						
	0.837635E 00	0.0	0.0	0.176857E 01	0.846278E 01	0.0
	0.0	0.0	-0.595620E 00	-0.545867E 00	-0.921283E-01	-0.251925E 01
ROW 5						
	0.0	0.837635E 00	0.0	-0.846278E 01	0.176857E 01	0.0
	0.0	0.0	0.921283E-01	0.251925E 01	-0.595620E 00	-0.545867E 00
ROW 6						
	0.0	0.0	-0.209071E 01	0.0	0.0	0.404194E 01
	0.126987E 01	0.110718E 01	0.0	0.0	0.0	0.0
ROW 7						
	0.0	0.0	-0.608883E 00	0.0	0.0	0.127153E 01
	0.428356E 00	0.376376E 00	0.0	0.0	0.0	0.0
ROW 8						
	0.0	0.0	-0.486722E 00	0.0	0.0	0.106497E 01
	0.370818E 00	0.357485E 00	0.0	0.0	0.0	0.0
ROW 9						

-0.320505E 00	0.0	0.0	-0.622602E 00	-0.921283E-01	0.0
0.0	0.0	0.214178E 00	0.188188E 00	0.842158E 00	0.139635E-04

ROW 10

-0.241604E 00	0.0	0.0	-0.542852E 00	-0.251925E 01	0.0
0.0	0.0	0.185409E 00	0.178743E 00	0.139635E-04	0.796345E 00

ROW 11

0.0	-0.320505E 00	0.0	0.921283E-01	-0.622602E 00	0.0
0.0	0.0	-0.842158E 00	-0.139635E-04	0.214178E 00	0.188188E 00

ROW 12

0.0	-0.241604E 00	0.0	0.251925E 01	-0.542852E 00	0.0
0.0	0.0	-0.139635E-04	-0.796345F 00	0.185409E 00	0.178743E 00

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR STIFFNESS DERIVATIVES

ROW 1

0.0	0.0	0.0	0.0	-0.103216E 03	0.0
0.0	0.0	0.0	0.0	-0.236224E 02	-0.178333E 02

ROW 2

0.0	0.0	0.0	0.103216E 03	0.0	0.0
0.0	0.0	0.236224E 02	0.178333E 02	0.0	0.0

ROW 3

0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0

ROW 4

0.0	0.869261E 01	0.0	0.0	-0.126981E 03	0.0
0.0	0.0	0.0	0.0	-0.380174E 02	-0.331242E 02

ROW 5

-0.869261E 01	0.0	0.0	0.126981E 03	0.0	0.0
0.0	0.0	0.380174E 02	0.331242E 02	0.0	0.0

ROW 6						
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
ROW 7						
	0.0	0.0	0.0	0.0	0.0	0.0
	0.444692E 02	0.575722E 01	0.0	0.0	0.0	0.0
ROW 8						
	0.0	0.0	0.0	0.0	0.0	0.0
	0.575722E 01	0.957550E 02	0.0	0.0	0.0	0.0
ROW 9						
	0.0	-0.352277E 01	0.0	0.0	0.449082E 02	0.0
	0.0	0.0	-0.422256E 01	-0.287817E 01	0.134572E 02	0.118242E 02
ROW 10						
	0.0	-0.115782E 01	0.0	0.0	0.352738E 02	0.0
	0.0	0.0	0.287817E 01	0.228596E 02	0.116496E 02	0.112307E 02
ROW 11						
	0.352277E 01	0.0	0.0	-0.449082E 02	0.0	0.0
	0.0	0.0	-0.134572E 02	-0.118242E 02	-0.422256E 01	0.287817E 01
ROW 12						
	0.115782E 01	0.0	0.0	-0.352738E 02	0.0	0.0
	0.0	0.0	-0.116496E 02	-0.112307E 02	0.287817E 01	0.228596E 02

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

ROTOR CONTRIBUTIONS TO THE INERTIA MATRIX

ROW 1

0.226526E-01	0.152741E-01	0.0	0.0	0.0	-0.[illegible]3677E-02
0.319774E-03	0.0	0.0			

ROW 2

0.152741E-01	0.391386E-01	0.0	0.0	0.0	-0.467728E-02
0.215615E-03	-0.479764E-03	-0.131191E-01			

ROW 3

0.0	0.0	0.111923E 00	0.612019E-03	0.195184E-01	-0.623165E-03
-0.170404E-01	0.535883E-02	-0.247033E-03			

ROW 4

0.0	0.0	0.612019E-03	0.134034E-01	0.222237E-06	0.0
0.0	0.0	0.0			

ROW 5

0.0	0.0	0.195184E-01	0.222237E-06	0.126742E-01	0.0
0.0	0.0	0.0			

```
ROW  6
   -0.693677E-02   -0.467728E-02   -0.623165E-03   0.0             0.0             0.670169E-02
    0.111118E-06    0.0             0.0
ROW  7
    0.319774E-03    0.215615E-03   -0.170404E-01   0.0             0.0             0.111118E-06
    0.633712E-02    0.0             0.0
ROW  8
    0.0            -0.479764E-03    0.535663E-02   0.0             0.0             0.0
    0.0             0.570169E-02    0.111118E-06
ROW  9
    0.0            -0.131191E-01   -0.247033E-03   0.0             0.0             0.0
    0.0             0.111118E-06    0.633712E-02

    C39 FINITE DEFLECTION STABILITY ANALYSIS
    SAMPLE PROBLEM
    ROTOR CONTRIBUTIONS TO THE DAMPING MATRIX

ROW  1
    0.363987E 00    0.245427E 00    0.599595E 00   0.0             0.0            -0.215865E 00
   -0.179092E 00    0.0             0.0
```

ROW 2						
	0.245427E 00	0.922857E 00	-0.458886E 01	0.0	0.0	-0.852636E-01
	0.152784E 01	-0.389774E 00	-0.357215E 00			
ROW 3						
	0.460565E 00	0.467475E 01	0.237123E 01	0.550802E 00	0.492519E 00	-0.506277E 00
	-0.463957E 00	0.884524E-01	-0.200301E 01			
ROW 4						
	0.0	0.0	0.608883E 00	0.428356E 00	0.376376E 00	0.0
	0.0	0.0	0.0			
ROW 5						
	0.0	0.0	0.466722E 00	0.370818E 00	0.357485E 00	0.0
	0.0	0.0	0.0			
ROW 6						
	-0.216277E 00	-0.206119E 00	-0.529212E 00	0.0	0.0	0.214178E 00
	0.188183E 00	0.842158E 00	0.139635E-04			
ROW 7						
	-0.163035E 00	-0.175852E 01	-0.461424E 00	0.0	0.0	0.185409E 00
	0.178743E 00	0.139635E-04	0.796345E 00			

```
ROW  8
     0.0            -0.407431E 00    0.243388E 00   0.0          0.0          -0.842158E 00
    -0.139635E-04    0.214178E 00    0.168188E 00
ROW  9
     0.0            -0.355242E 00    0.226731E 01   0.0          0.0          -0.139635E-04
    -0.796345E 00    0.165409E 00    0.178743E 00
     C39 FINITE DEFLECTION STABILITY ANALYSIS
     SAMPLE PROBLEM
     ROTOR CONTRIBUTIONS TO THE STIFFNESS MATRIX

ROW  1
     0.0            -0.455791E 02    0.0            0.0          0.0           0.0
     0.0            -0.159404E 02   -0.120339E 02
ROW  2
    -0.383856E 01   -0.333210E 02    0.706319E 02   0.0          0.0           0.243786E 02
     0.216765E 02   -0.107482E 02   -0.811417E 01
ROW  3
     0.0            -0.706319E 02   -0.495873E 02   0.0          0.0          -0.123143E 02
    -0.929652E 01   -0.323148E 02   -0.281555E 02
```

ROW 4					
0.0	0.0	0.0	0.444692E 02	0.575722E 01	0.0
0.0	0.0	0.0			
ROW 5					
0.0	0.0	0.0	0.575722E 01	0.957550E 02	0.0
0.0	0.0	0.0			
ROW 6					
0.0	0.293879E 02	0.163642E 01	0.0	0.0	-0.422256E 01
0.287817E 01	0.134572E 02	0.118242E 02			
ROW 7					
0.0	0.230832E 02	0.603571E 00	0.0	0.0	0.287817E 01
0.228596E 02	0.116496E 02	0.112307E 02			
ROW 8					
0.237716E 01	0.160286E 01	-0.381719E 02	0.0	0.0	-0.134572E 02
-0.118242E 02	-0.422256E 01	0.287817E 01			
ROW 9					
0.781297E 00	0.526508E 00	-0.299828E 02	0.0	0.0	-0.116496E 02
-0.112307E 02	0.287817E 01	0.228596E 02			

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

AIRFRAME COMPONENTS

RIGHT WING	NOT PRESENT
LEFT WING	PRESENT
FUSELAGE	NOT PRESENT
RIGHT TAIL	NOT PRESENT
LEFT TAIL	NOT PRESENT
FIN	NOT PRESENT

AIRFRAME AERODYNAMICS   NOT INCLUDED

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

LEFT WING PARAMETERS

NO. OF SEGMENTS = 6

ELASTIC MODE SHAPES

0.0	0.0	-0.126000E-01	0.0	0.0	0.0
0.0	0.0	-0.450000E-01	0.0	0.0	0.0
0.0	0.0	-0.172100E 00	0.0	0.0	0.0
0.0	0.0	-0.437900E 00	0.0	0.0	0.0
0.0	0.0	-0.566600E 00	0.0	0.0	0.0
0.0	0.0	-0.674800E 00	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.545000E-01	0.0
0.0	0.0	0.0	0.0	0.105800E 00	0.0
0.0	0.0	0.0	0.0	0.233100E 00	0.0
0.0	0.0	0.0	0.0	0.439100E 00	0.0
0.0	0.0	0.0	0.0	0.557200E 00	0.0
0.0	0.0	0.0	0.0	0.654400E 00	0.0
-0.224000E-01	0.0	0.0	0.0	0.0	-0.118000E 00
-0.779999E-01	0.0	0.0	0.0	0.0	-0.205000E 00
-0.273900E 00	0.0	0.0	0.0	0.0	-0.276000E 00
-0.641100E 00	0.0	0.0	0.0	0.0	-0.415000E 00
-0.811000E 00	0.0	0.0	0.0	0.0	-0.550000E 00
-0.100000E 01	0.0	0.0	0.0	0.0	-0.850000E 00

COORDS. OF SEGMENT REF. POINTS IN A/C AXES

X(FT.)	Y(FT.)	Z(FT.)
0.0	-0.458300E 00	0.0
0.0	-0.875000E 00	0.0
0.0	-0.170800E 01	0.0
0.0	-0.275000E 01	0.0
0.0	-0.316700E 01	0.0
0.0	-0.339400E 01	0.0

LOCAL 'PITCH' SETTINGS (DEGREES)

0.0	0.0	0.0	0.0	0.0
0.0				

MASS POINT COORDS. IN LOCAL AXES

X(FT.)	Y(FT.)	Z(FT.)
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0

MASS (SLUGS)	MASS MOMENTS OF INERTIA (SLUGS-FT.**2)		
0.572000E-01	0.700000E-03	0.710000E-02	0.700000E-03
0.530000E-01	0.130000E-02	0.132000E-01	0.130000E-02
0.107100E 00	0.200000E-02	0.179000E-01	0.200000E-02
0.130000E 00	0.150000E-02	0.146000E-01	0.150000E-02
0.576000E-01	0.500000E-03	0.530000E-02	0.500000E-03
0.0	0.0	0.0	0.0

```
C39 FINITE DEFLECTION STABILITY ANALYSIS
SAMPLE PROBLEM

AIRFRAME CONTRIBUTIONS TO THE INERTIA MATRIX

ROW  1
    0.109092E 00    0.336509E-01    0.0
ROW  2
    0.336509E-01    0.110686E 00    0.0
ROW  3
    0.0             0.0             0.407307E 00

DAMPING OPTION SELECTED
VISCOUS

AIRFRAME FREQUENCIES
    0.487800E 02    0.584500E 02    0.891900E 02

VISCOUS DAMPING COEFFICIENTS (AS FRACTIONS OF MODAL CRITICAL DAMPING COEFFS.)
    0.200000E-01    0.200000E-01    0.200000E-01

STRUCTURAL DAMPING COEFFICIENTS (AS FRACTIONS OF DIRECT MODAL STIFFNESSES)
    0.0             0.0             0.0
```

```
C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM


AIRFRAME CONTRIBUTIONS TO THE STIFFNESS MATRIX

ROW  1

     0.259583E 03   0.0            0.0

ROW  2

     0.0            0.378149E 03   0.0

ROW  3

     0.0            0.0            0.324006E 04

AIRFRAME CONTRIBUTIONS TO THE DAMPING MATRIX

ROW  1

     0.212860E 00   0.0            0.0

ROW  2

     0.0            0.258785E 00   0.0

ROW  3

     0.0            0.0            0.145311E 01
```

C39 FINITE DEFLECTION STABILITY ANALYSIS

SAMPLE PROBLEM

FINAL INERTIA MATRIX

ROW 1					
0.131745E 00	0.489250E-01	0.0	0.0	0.0	-0.693677E-02
0.319774E-03	0.0	0.0			
ROW 2					
0.489250E-01	0.147025E 00	0.0	0.0	0.0	-0.467728E-02
0.215615E-03	-0.479764E-03	-0.131191E-01			
ROW 3					
0.0	0.0	0.519229E 00	0.612019E-03	0.195184E-01	-0.623165E-03
-0.170404E-01	0.535883E-02	-0.247033E-03			
ROW 4					
0.0	0.0	0.612019E-03	0.134034E-01	0.222237E-06	0.0
0.0	0.0	0.0			
ROW 5					
0.0	0.0	0.195184E-01	0.222237E-06	0.126742E-01	0.0
0.0	0.0	0.0			

```
ROW  6
  -0.693677E-02   -0.467728E-02   -0.623165E-03   0.0   0.0   0.670169E-02
   0.111116E-06    0.0             0.0
ROW  7
   0.319774E-03    0.215615E-03   -0.170404E-01   0.0   0.0   0.111118E-06
   0.633712E-02    0.0             0.0
ROW  8
   0.0            -0.479764E-03    0.535883E-02   0.0   0.0   0.0
   0.0             0.670169E-02    0.111118E-06
ROW  9
   0.0            -0.131191E-01   -0.247033E-03   0.0   0.0   0.0
   0.0             0.111118E-06    0.633712E-02

   C39 FINITE DEFLECTION STABILITY ANALYSIS
   SAMPLE PROBLEM
   FINAL DAMPING MATRIX

ROW  1
   0.576848E 00    0.245427E 00    0.599595E 00   0.0   0.0   -0.215865E 00
  -0.179092E 00    0.0             0.0
```

ROW 2

0.245427E 00	0.118164E 01	-0.458886E 01	0.0	0.0	-0.852636E-01
0.152784E 01	-0.389774E 00	-0.357215E 00			

ROW 3

0.480565E 00	0.467475E 01	0.382434E 01	0.550802E 00	0.492519F 00	-0.506277E 00
-0.463987E 00	0.884524E-01	-0.200301E 01			

ROW 4

0.0	0.0	0.608883E 00	0.428356F 00	0.376376E 00	0.0
0.0	0.0	0.0			

ROW 5

0.0	0.0	0.486722E 00	0.370618F 00	0.357485E 00	0.0
0.0	0.0	0.0			

ROW 6

-0.216277E 00	-0.206119E 00	-0.529212E 00	0.0	0.0	0.214178E 00
0.188188E 00	0.842158E 00	0.139635E-04			

ROW 7

-0.163035E 00	-0.175852E 01	-0.461424E 00	0.0	0.0	0.185409E 00
0.178743E 00	0.139635E-04	0.796345E 00			

```
ROW  8
   0.0              -0.407431E 00    0.245388E 00    0.0              0.0              -0.842158E 00
  -0.139635E-04      0.214178E 00    0.188188E 00
ROW  9
   0.0              -0.355242E 00    0.226731E 01    0.0              0.0              -0.139635E-04
  -0.796345E 00      0.185409E 00    0.178743E 00

   C39 FINITE DEFLECTION STABILITY ANALYSIS
   SAMPLE PROBLEM
   FINAL STIFFNESS MATRIX

ROW  1
   0.259583E 03     -0.455791E 02    0.0              0.0              0.0               0.0
   0.0              -0.159404E 02   -0.120339E 02
ROW  2
  -0.383856E 01      0.344828E 03    0.706319E 02    0.0              0.0               0.248786E 02
   0.216765E 02     -0.107482E 02   -0.811417E 01
ROW  3
   0.0              -0.706319E 02    0.319046E 04    0.0              0.0              -0.123143E 02
  -0.929652E 01     -0.323148E 02   -0.281555E 02
```

```
ROW   4
      0.0             0.0             0.0             0.444692E 02    0.575722E 01    0.0
      0.0             0.0             0.0
ROW   5
      0.0             0.0             0.0             0.575722E 01    0.957550E 02    0.0
      0.0             0.0             0.0
ROW   6
      0.0             0.293879E 02    0.183642E 01    0.0             0.0            -0.422256E 01
      0.287817E 01    0.134572E 02    0.118242E 02
ROW   7
      0.0             0.230832E 02    0.603571E 00    0.0             0.0             0.287817E 01
      0.228596E 02    0.116496E 02    0.112307E 02
ROW   8
      0.237716E 01    0.160286E 01   -0.381719E 02    0.0             0.0            -0.134572E 02
     -0.118242E 02   -0.422256E 01    0.287817E 01
ROW   9
      0.781297E 00    0.526808E 00   -0.299628E 02    0.0             0.0            -0.116496E 02
     -0.112307E 02    0.287817E 01    0.228596E 02
```

VIBRATION MATRIX SOLUTION

SAMPLE PROBLEM

COMPLEX ROOTS
OF THE MATRIX

ROOT NO.	REAL PART	IMAGINARY PART	FREQUENCY IN CPS	PER CENT CRITICAL DAMPING	NO. OF ITER-ATIONS	ROOT NO.	
1	-0.79184747E-03	-0.10586504E-01	14.950	-7.46	8	1	1
2	-0.10885147E-02	-0.72808526E-02	21.381	-14.79	5	2	2
3	-0.41828537E-03	-0.72467402E-02	21.889	-5.76	3	3	3
4	-0.92555094E-03	-0.14188442E-01	11.170	-6.51	6	4	4
5	-0.11724816E-02	-0.14539778E-01	10.875	-8.04	3	5	5
6	-0.47974735E-02	-0.14423348E-01	9.935	-31.56	3	6	6
7	-0.10883764E-02	0.72807893E-02	21.382	-14.78	5	7	
8	-0.41853637E-03	0.72467290E-02	21.889	-5.77	3	8	
9	-0.79194293E-03	0.10586645E-01	14.950	-7.46	3	9	
10	-0.92568481E-03	0.14187332E-01	11.171	-6.51	6	10	
11	-0.11725884E-02	0.14540628E-01	10.875	-8.04	3	11	
12	-0.47972053E-02	0.14423396E-01	9.935	-31.56	2	12	
13	-0.10099267E-02	-0.25522720E-01	6.226	-3.95	3	13	7
14	-0.10098401E-02	0.25522433E-01	6.226	-3.95	2	14	
15	-0.50953884E-01	-0.21306892E-06	0.000	-100.00	4	15	8
16	-0.54431979E-01	0.15531532E-06	0.000	-100.00	2	16	
17	-0.38124356E-01	-0.52732792E-01	1.982	-58.59	3	17	9
18	-0.38124841E-01	0.52732863E-01	1.982	-58.59	0	18	

REAL TRACE OF INPUT MATRIX= 0.0 IMAG TRACE OF INPUT MATRIX= -0.20204353E 00

REAL TRACE OF HESS MATRIX = 0.0 IMAG TRACE OF HESS MATRIX = -0.20204288E 00

REAL TRACE OF FINAL MATRIX= 0.46566129E-06 IMAG TRACE OF FINAL MATRIX= -0.20204276E 00

VECTOR FOR ROOT NO. 1 WHICH IS (-0.79184747E-03 -0.10586504E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.20909980E-01	-0.35925791E-01	0.0415679	239.79
1	-0.18660367E-01	-0.68387948E-02	0.0198741	200.12
1	-0.17272174E 00	0.66337788E-01	0.1852028	158.86
1	-0.77050507E-01	0.30510986E 00	0.3146883	104.18
1	0.10000000E 01	0.0	1.0000000	0.0
1	-0.37121522E 00	-0.61352062E 00	0.7170831	238.81
1	-0.51774812E 00	0.53092957E-01	0.5204632	174.16
1	-0.43687272E 00	0.29119849E 00	0.5250279	146.33
1	-0.86401701E-01	-0.76582551E-01	0.1154562	221.54

VECTOR FOR ROOT NO. 2 WHICH IS (-0.10885147E-02 -0.72808526E-02) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.56419712E-01	-0.25919843E-02	0.0564792	357.37
1	-0.51769167E-02	-0.82396157E-02	0.0097310	237.85
1	0.63911900E-02	0.75487792E-02	0.0098910	49.75
1	0.10260437E-02	-0.24717208E-02	0.0026762	292.54
1	-0.16499925E-01	-0.18785834E-01	0.0250031	228.70
1	0.10000000E 01	0.0	1.0000000	0.0
1	0.32745177E 00	-0.70655888E 00	0.7787490	294.86
1	0.82354271E-03	-0.97885579E 00	0.9788561	270.04
1	-0.73963565E 00	-0.33167201E 00	0.8105967	204.14

VECTOR FOR ROOT NO. 3 WHICH IS (-0.41626537E-03 -0.72467402E-02) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.48054598E-01	-0.22410735E-01	0.0530234	204.99
1	0.12078784E-01	-0.10224450E-01	0.0158252	319.75
1	0.92322901E-02	-0.37964315E-02	0.0099824	337.65
1	-0.10827994E-02	-0.18120597E-02	0.0021109	239.13
1	-0.23284614E-01	0.73383152E-02	0.0244136	162.52
1	-0.77794760E 00	-0.48295093E 00	0.9156659	211.82
1	0.83173774E-02	0.96346092E 00	0.9634968	89.51
1	-0.47185057E 00	0.76173860E 00	0.8960406	121.78
1	0.10000000E 01	0.0	1.0000000	0.0

VECTOR FOR ROOT NO. 4 WHICH IS (-0.92555094E-03 -0.14188442E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.37539959E 00	0.21962887E 00	0.4349272	149.68
1	0.44677138E 00	-0.23148632E 00	0.5031804	332.61
1	0.47895964E-01	-0.44742264E-01	0.0655431	316.95
1	0.30835211E 00	0.46379024E 00	0.5569402	56.39
1	0.15676540E 00	-0.56261611E 00	0.5840482	285.56
1	-0.24555558E 00	0.36639041E 00	0.4410661	123.84
1	-0.18502608E-01	-0.32298434E 00	0.3235139	266.71
1	0.33520412E 00	0.57119679E 00	0.6622895	59.60
1	0.10000000E 01	0.0	1.0000000	0.0

VECTOR FOR ROOT NO. 5 WHICH IS (-0.11724816E-02 -0.14539778E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.73533535E-01	-0.41576896E-01	0.0844737	330.51
1	-0.58649234E-01	0.21904331E-01	0.0626062	159.53
1	-0.50145496E-01	-0.94969511E-01	0.1073954	242.16
1	0.10000000E 01	0.0	1.0000000	0.0
1	-0.58800632E 00	-0.70046771E 00	0.9145526	229.98
1	0.30581790E 00	-0.15334839E 00	0.3421115	333.37
1	0.11712571E-02	-0.24297035E 00	0.2429731	270.27
1	-0.10881203E 00	-0.21942836E 00	0.2449262	243.62
1	-0.47393315E-01	-0.53638209E-01	0.0715764	228.53

VECTOR FOR ROOT NO. 6 WHICH IS (-0.47974735E-02 -0.14423348E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.62988259E-02	0.97873062E-02	0.0116390	57.24
1	0.29021096E-02	-0.42418577E-02	0.0051396	304.37
1	0.37090093E-01	-0.17201930E-01	0.0408850	335.12
1	0.10000000E 01	0.0	1.0000000	0.0
1	0.23041499E 00	-0.47979802E 00	0.5322566	295.65
1	0.33963103E-01	0.11381853E 00	0.1187777	73.39
1	0.11151850E 00	-0.16555376E-02	0.1115308	359.15
1	0.64563453E-01	-0.50957575E-02	0.0647642	355.49
1	0.35417207E-01	0.31100318E-01	0.0471339	41.29

VECTOR FOR ROOT NO. 7 WHICH IS (-0.10099267E-02 -0.25522720E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	-0.26312929E-02	-0.81249434E 00	0.8124986	269.81
1	-0.80735207E-01	-0.28863335E 00	0.2997121	254.37
1	0.63240603E-02	0.10462345E-02	0.0064100	9.39
1	-0.27268801E-02	-0.56545809E-02	0.0062777	244.25
1	0.18253713E-02	-0.36020530E-03	0.0018606	348.84
1	0.10432506E 00	0.42262304E 00	0.4353091	76.14
1	-0.21306330E 00	-0.15862143E 00	0.2656251	216.66
1	0.10000000E 01	0.0	1.0000000	0.0
1	0.27796543E 00	-0.54798532E 00	0.6144531	296.89

VECTOR FOR ROOT NO. 8 WHICH IS (-0.50953384E-01 -0.21306692E-06) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.63915431E-01	0.65269188E-06	0.0639154	0.00
1	0.12639698E-01	-0.27770784E-06	0.0126397	360.00
1	0.89880563E-02	0.25775950E-07	0.0089881	0.00
1	0.25633895E-02	-0.58276061E-07	0.0025634	360.00
1	0.23711230E-03	0.10310380E-07	0.0002371	0.00
1	-0.34274209E 00	0.11475901E-04	0.3427421	180.01
1	-0.59139216E 00	0.40165656E-06	0.5913922	180.01
1	0.10000000E 01	0.0	1.0000000	0.0
1	-0.19373617E-02	-0.11026504E-04	0.0019374	180.31

VECTOR FOR ROOT NO. 9 WHICH IS (-0.33124356E-01 -0.52732792E-01) FOLLOWS

UNREDUCED MATRIX ROW NUMBER	REAL PART	IMAGINARY PART	AMPLITUDE	PHASE ANGLE IN DEGREES
1	0.22383489E-01	0.33937313E-01	0.0406542	56.60
1	-0.11707902E 00	-0.44796802E-02	0.1171647	182.18
1	0.46122517E-03	0.16470674E-01	0.0164771	88.40
1	0.33476588E-02	0.19236812E-02	0.0038612	29.88
1	0.35512098E-03	0.81352983E-03	0.0008877	66.42
1	0.78233379E 00	0.42259026E 00	0.8891729	28.38
1	-0.20935554E-01	-0.97274244E 00	0.9729677	268.76
1	0.11738636E-01	0.47225112E 00	0.4723970	88.58
1	0.10000000E 01	0.0	1.0000000	0.0

NOTE: Output sheets for subsequent cases have been deliberately omitted from this document.

DISCUSSION OF PROGRAM USAGE

The rotor airloads calculations make use of lift curve slopes input to the program. It is well-known from test data that the theoretical value of 2π is generally too high. A value of 5.73 appears to be a more realistic average and is recommended as a starting trial value when no test data for the particular blade profile is available. Where reliable test data exists, it should form the basis of the input lift curve slopes.

The induced airflow through the rotor disc does influence the airloads calculations, especially at low advance ratios. Where no significant interference exists between the airframe components and the airflow at the rotor disc, it has been found adequate to include only the airscrew-induced velocity as a uniform axial velocity field calculated from a simple momentum theory.

The looping options provide for changes to some of the input data without affecting others. The concept involves some basic assumptions which must be borne in mind when the features are used. In the rotor system, for example, the blade modes do not change when airspeed and/or blade steady deflections are varied under options 1, 2, or 3. This is obviously an approximation whose validity must be critically examined in each application.

The routine used in solving the equations of motion involves inversion of the stiffness matrix. When rigid aircraft translational modes are included in the analysis but no airframe aerodynamics are specified, the resulting stiffness matrix is singular and no solution can be obtained. In such circumstances it is advisable to specify the rigid translational modes as airframe ELASTIC MODES, with the mode shapes at each discrete point reflecting the actual motion under the rigid mode. Small insignificant modal frequencies can then be specified for these modes to keep the stiffness matrix non-singular. Alternatively, the landing gear facilities can be used to provide stiffness terms in the rigid translational modes without affecting the overall dynamics of the system.

Part II. User's Manual: Computer Program for Aeroelastic Prop/Rotor Loads Analysis

F. J. Tarzanin

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INTRODUCTION

The Aeroelastic Prop/Rotor Analysis Program calculates the following for a single- or tandem-rotor aircraft in hover, axial flight, or edgewise flight (i.e., helicopter configuration):

- o Blade Airloads - Including downwash, lift, drag, aerodynamic pitching moment, angle of attack, and unsteady aerodynamic parameters, all as a function of blade azimuth and radial position
- o Aerodynamic Performance Parameters - Including shaft angle relation to free stream; advance ratio; rotor thrust, drag, propulsive force, lift, torque, and horsepower; and nondimensionalized rotor thrust, drag, propulsive force, lift, torque, and horsepower.
- o Blade Response - Including linear and angular deflections, velocities and accelerations, and shear and bending moment distributions
- o Rotating and Fixed System Hub Loads
- o Pitch Link and Control System Actuator Loads

The method used employs an iterative technique between the airloads calculations and the blade response. Indicators of program convergence are given on the last two pages of the output.

The required input data consists of:

- o Blade Physical Properties
- o Blade Airfoil Characteristics
- o Trim Data
- o Specification of Program Controls

BLADE PHYSICAL PROPERTIES

The analysis idealizes the blade into a series of bays. The bay boundaries are defined in input locations 290-310. The total mass of each bay is located midway between the boundaries. The masses are assumed to be connected by massless beams which possess flap, lag, and torsional stiffness. Blade property curves specify the spanwise distributions of blade weight, chordwise centroid location, polar moment of inertia, and flap, lag, and torsional stiffness distribution. The lumped blade properties are obtained by inputting the distributed properties into the D-01 computer program and running subroutine WICK. A brief description of D-01, including a description of the input and a sample case based on the distributed properties, is given in a later section. The output of D-01 subroutine WICK may be directly input into the program.

BLADE AIRFOIL CHARACTERISTICS

Blade airfoil characteristics for each blade cross section are defined by C_L, C_D, and C_M airfoil decks. The appropriate deck must be added to the front of the input data at all times, even when the linear aero option is used. A dummy deck should be used since the program reads the tables before the linear aero controls. If a blade with a variable airfoil section is analyzed, more than one set of airfoil tables will be needed (see input description of locations 221-223). A detailed discussion of the airfoil tables is presented later.

Lift and moment γ function values associated with each airfoil section are input into locations 145-180. If only a single airfoil table is used, locations 157 to 180 and 221 to 223 may be set equal to 0.

TRIM DATA

Trim data is usually obtained from either a description of wind tunnel operating conditions or by inputting flight test conditions into the Y-14 trim program for a single-rotor helicopter or the A-97 trim program for a tandem-rotor helicopter. Program A-97 is described in a subsequent section. Included is a sample input and output which serves as the basis for the sample C-70 case presented later. The program input description (see locations 1-21) illustrates how trim is obtained from the A-97 output. For a single-rotor helicopter, locations 15-21 may be set equal to 0.

SPECIFICATION OF PROGRAM CONTROLS

The computer program contains a large number of computational options; many of these options are used for special purposes only. For this reason a detailed discussion of all available options is not presented. The input sheets presented later indicate usual values for the program controls. Deviation from the suggested values should be done with due consideration. The other input locations indicate the usual source of the input data.

Location 46 specifies which rotor of a tandem helicopter is to be analyzed. When analyzing the forward rotor set location 46 equal to 1. For the aft rotor set location 46 equal to 2. Locations 282 and 283 are used to locate one rotor with respect to the other (see input description). For a single-rotor helicopter, set location 46 equal to 1 and locations 282 and 283 equal to 0.

The most basic option in this program is a choice between uniform downwash and nonuniform downwash. The type of downwash used by the program is controlled by locations 92 and

93 (location 93 has no effect in the case of uniform downwash). Most users will utilize either location 92 equal to 0 (nonuniform downwash) or location 92 equal to 2 (uniform downwash). When location 92 equals 1, the program reads the downwash as input from locations 586 to 1165. This option is useful for analyzing prop/rotors in axial flow, where the wing circulation generates a downwash field through the rotor.

If uniform downwash is used, set locations 93 to 115 equal to 0 EXCEPT LOCATION 94 WHICH MUST BE SET EQUAL TO 1.

If the nonuniform downwash option is used then the controls in locations 93 to 115 must be carefully specified. When a tandem-rotor helicopter is being analyzed, the downwash from each rotor interferes with the other. Therefore, the downwash of both rotors must be calculated (deflections and loads are calculated only for the rotor specified in location 46). If a single rotor is being analyzed, set location 93 equal to 1 and only one rotor is analyzed. For a tandem-rotor helicopter set location 93 equal to 2.

Locations 94 and 95 are not operational at the time of this writing and must be set equal to 1 and 0, respectively.

The program calculates nonuniform downwash by an iterative process; these downwash iterations are referred to as loops. The looping process is used to insure compatibility between downwash, lift, and vortex circulation strength. The looping is performed separately for each rotor. Location 96 specifies the number of loops performed on the rotor being analyzed (as specified in location 46) and location 97 specifies the number of loops performed on the interfering rotor. Note that location 97 equals the number of loops for the interfering rotor and that location 96 MINUS 1 is the number of loops for the rotor being analyzed. Generally the same number of loops are required for both rotors; hence, location 96 must be 1 larger than location 97. For a single-rotor helicopter location 97 is set equal to 0. When the convergence factors described in locations 108 to 111 are used, most users should be able to set location 96 equal to 1 and location 97 equal to 0 and achieve sufficiently accurate values of circulation strength. Do not input values larger than 10 in locations 96 and 97. A tabulation of circulation strengths for each downwash loop and a summary of the thrust routines is provided to indicate the convergence of the looping process.

The program calculates nonuniform downwash by assuming that each blade trails vortices in space. These vortices are idealized into a series of straight-line segments. The downwash at a given point is calculated by applying the Biot-Savart law to each straight-line segment and then summing for all segments. Location 98 specifies the length of vortex (in

rotor revolutions) which is considered effective in producing downwash. The input description gives an equation by which this input value may be calculated.

Locations 99 and 100 specify the inboard and outboard radial positions respectively from which the vortices are trailed. Usually (but not necessarily) the vortices are trailed from the blade cutout and tip.

Locations 101 and 102 are not operational at the time of this writing and must be set equal to 0.

In order to speed the convergence of the downwash looping process, values of circulation strength obtained in successive loops are modified: i.e., only a portion of the change is added to the value obtained in the previous loop. Locations 103 and 104 control the amount of the change which is added. Usually locations 103 and 104 are set equal to 90. This means that 10 percent of the change in circulation strength is added to the value obtained in the previous loop. If a single rotor is being analyzed, only location 103 must be specified; for a tandem both locations 103 and 104 must be specified.

The magnitude of the circulation strength depends on lift. Locations 105 and 106 indicate the number of blade bays which are used to obtain the lift for the outboard and inboard trailed vortices respectively. Usually both locations 105 and 106 are set equal to 1. This means that only the aerodynamic bays at the extremes of the airfoil (blade tip and cutout) are used to determine lift. If both locations are set equal to 2, then the lift used will be the average over two bays and so on. Locations 105 and 106 do not have to be equal.

The Biot-Savart law predicts a $1/R^2$ relationship between the downwash at a given point and the distance, R, to a vortex segment. Thus if a blade intersected a vortex very large values of downwash would result. In order to avoid this the program limits the downwash velocity obtained in any individual blade-vortex interaction to 0.1 of the blade tipspeed. When location 107 is set equal to 1, no upper limit is imposed. The user is advised to set location 107 equal to 0.

Experience has shown that the circulation strengths obtained from the initial lift distribution are significantly higher than the values needed for lift-circulation strength-downwash compatibility. Therefore, in order to speed convergence a set of empirical factors has been found which, when applied to the zero-loop circulation strengths, give the approximate values. (In this way the number of downwash loops can be reduced.) These factors are plotted as a function of airspeed and are input into locations 108 to 111. If zeros are input into these locations, then the factors are taken to be 0.1.

Locations 112 to 115 specify factors which modify the circulation strengths in all (including the zeroth) loops. Usually it is unnecessary to further modify the circulation strengths and these factors should be set equal to 1. Do not set locations 112 to 115 equal to 0 as this will zero out the downwash.

The input sheets give the source for the required data and indicate suggested values for the program controls. Locations 40, 41, and 61 show two values. The values on the left are to be used with uniform downwash (location 92 equal to 2) and those on the right should be used with nonuniform downwash (location 92 equal to 0).

The computer program uses an iterative technique between the airloads and coupled flap-pitch response. The number of iterations performed is specified in location 48. It is suggested that 10 iterations be used (the maximum) to provide the greatest likelihood of program convergence. Indicators of convergence are printed on the last two pages of output.

Locations 65 to 69 control which parameters are included in the program printout. For most users the values suggested on the input sheet will provide sufficient information regarding the intermediate iterations (see sample output). Setting location 65 equal to 1 will provide complete output for all iterations. Note that lag and hub load calculations are performed in the last iteration only.

The options specified in locations 586 to 1300 are not needed by most users and so should be left blank; i.e., only input sheets 1 and 2 need to be completed. In general, zeros need not be filled in; the program will insert zeros in all blank input locations.

AIRFOIL DECKS

When large-scale, high-speed electronic computers became available for engineering use, it became possible to remove many of the rather dubious and extreme simplifying assumptions which had been necessary in the analysis of rotors. One of the first tasks undertaken in making rotor calculations more rigorous was to replace linearized airfoil behavior with experimental data, including all the awkward irregularities associated with stall and operation above the critical Mach number.

This was done by using airfoil decks, consisting of IBM cards, that defined an airfoil's C_L, C_D, and C_M characteristics versus angle of attack and Mach number. A description of the airfoil decks and a sample deck are presented later.

Characteristics of Airfoil Tables

Lift, drag, and pitching moment coefficients for airfoils vary widely with details of section geometry in the range of moderate positive or negative angles of attack. For angles outside the range of -20 to +20 degrees angle of attack, however, most profiles of interest to the blade designer behave very much alike. It is therefore convenient to specify a single function to be used for all different airfoil sections in that range of angles. Within the moderate angle-of-attack range, aerodynamic coefficients will be specified in tabular form against the two arguments: angle of attack (α) and Mach number (M), which defines the airfoil deck. Outside this range simplified equations that are written into the rotor analysis are used to define C_L, C_D, and C_M as a function of angle of attack.

The range for which tabulated data is required for lift coefficient (C_L) is ±20 degrees; for drag coefficient (C_D), from negative stall to positive stall, where the stall angles are input as $\alpha_{NEG\ STALL}$ and α_{STALL}.

Lift Coefficient Deck

Lift data in the moderate angle-of-attack range is specified by α-C_L pairs at fixed Mach number. Up to 10 Mach numbers may be used with 15 C_L-α pairs per Mach number.

The following formulae and the curve in Figure 6 define the single C_L-α relation used for all airfoils in the range not covered by the tables discussed above. The formulae are part of the computer program, but it will be noted that four constants (K_1, K_2, K_3, K_4) are also required. These are normally taken as one, but may be adjusted to suit the needs of unusual configurations. Note that K_2 is related to another input constant (C_{L180}) and that they must be mutually consistent. Figure 6 shows the C_L-α relation from +20 to 340 degrees (-20 degrees) for all K's = 1 and C_{L180} = 0.

The following are equations of line segments defining the airfoil lift coefficient at large angles of attack:

The value δ equals α from 20 degrees through 180 degrees and equals (360 degrees - α) above 180 degrees up to 340 degrees.

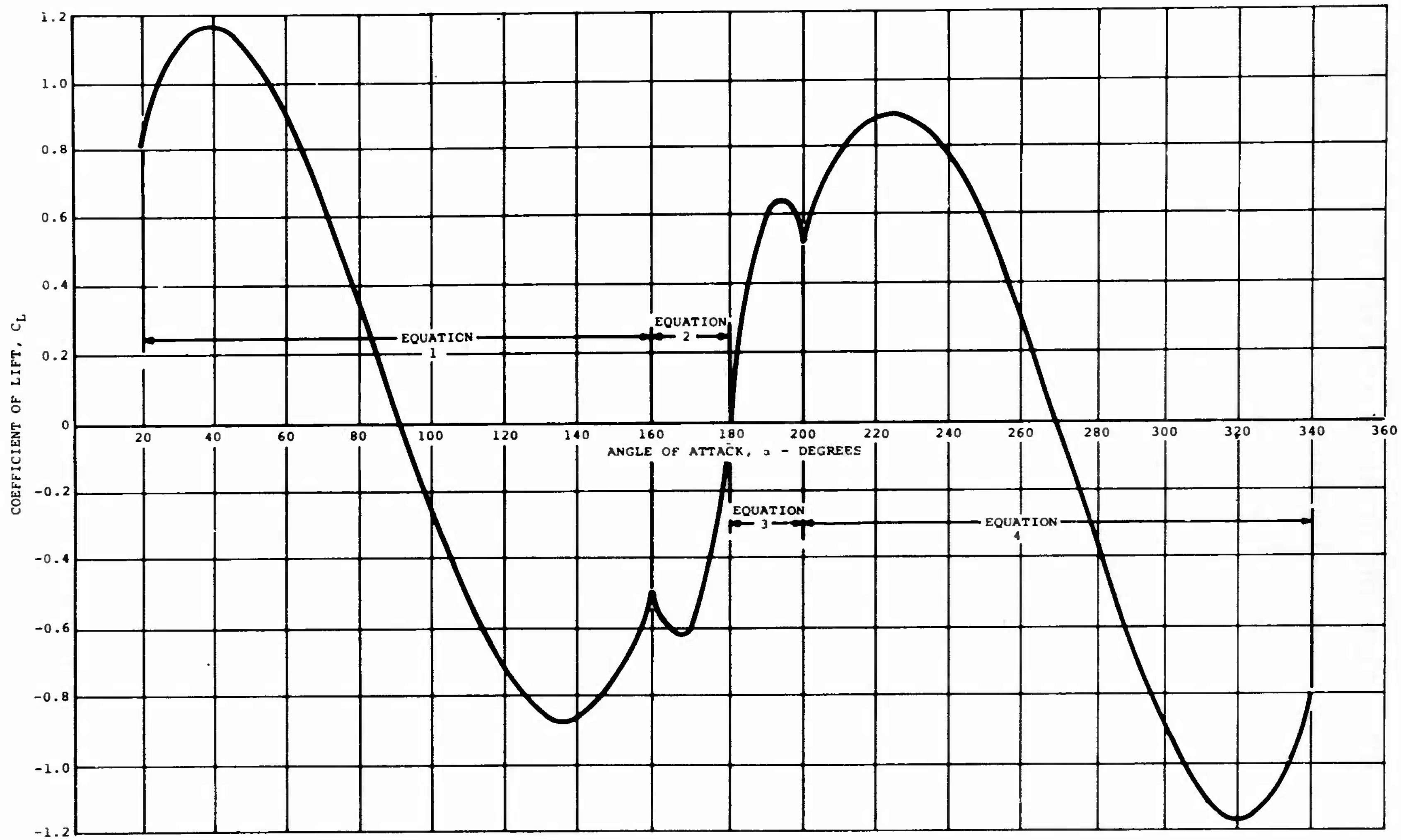


Figure 6. Lift Coefficient Versus Angle of Attack for All Airfoils

(1) $\underline{20° < \alpha \le 160°}$ $C_L = (K_1 \text{ or } K_2) \times (-0.42045519 + 0.08899219$

$\times \delta - 1.5350914 \times 10^{-3} \times \delta^2 + 7.4254402$

$\times 10^{-6} \times \delta^3 - 8.2868165 \times 10^{-9} \times \delta^4)$

$(K_1 \text{ for } 20° < \alpha \le 90°,\ K_2 \text{ for } 90° < \alpha \le 160°)$

(2) $\underline{160° < \alpha \le 180°}$ $C_L = (K_2) \times (99.79237 - 1.2027941 \times \delta$

$+ 0.0036020154 \times \delta^2) + C_{L180} \left(\frac{\delta - 160}{20}\right)$

(3) $\underline{180° < \alpha \le 200°}$ $C_L = (K_3) \times (-99.79237 + 1.2027941$

$\times \delta - 0.0036020154\ \delta^2) + C_{L180} \left(\frac{\delta - 160}{20}\right)$

(4) $\underline{200° < \alpha < 340°}$ $C_L = (K_3 \text{ or } K_4) \times (0.42045519 - 0.08899219$

$\times \delta + 1.5350914 \times 10^{-3} \times \delta^2 - 7.4254402$

$\times 10^{-6} \times \delta^3 + 8.2868165 \times 10^{-9} \times \delta^4)$

$(K_3 \text{ for } 200° < \alpha \le 270°,\ K_4 \text{ for } 270° < \alpha < 340°)$

Drag Coefficient Deck

In the unstalled range, drag data are specified in the form C_D-M pairs for constant values of α. Up to 15 values of α may be used, each with up to 7 C_D-M pairs. In addition, α's for negative and positive stall must be specified.

The function applicable between the stall angles is given in the following equations and the curve in Figure 7.

The following are equations of line segments defining the airfoil drag coefficient at large angles of attack:

(5) $C_D = -1.0783242 + 0.10546602 \times \nu - 0.0022458297 \times \nu^2$

$+ 2.543888 \times 10^{-5} \times \nu^3 - 1.0989072 \times 10^{-7} \times \nu^4$

where $\nu = \alpha + (15° - \alpha_{stall}) \left(\frac{90° - \alpha}{90° - \alpha_{stall}}\right)$ for $\alpha_{stall} < \alpha \le 90°$

and $\nu = (180° - \alpha)$ for $90° < \alpha \le 166°$

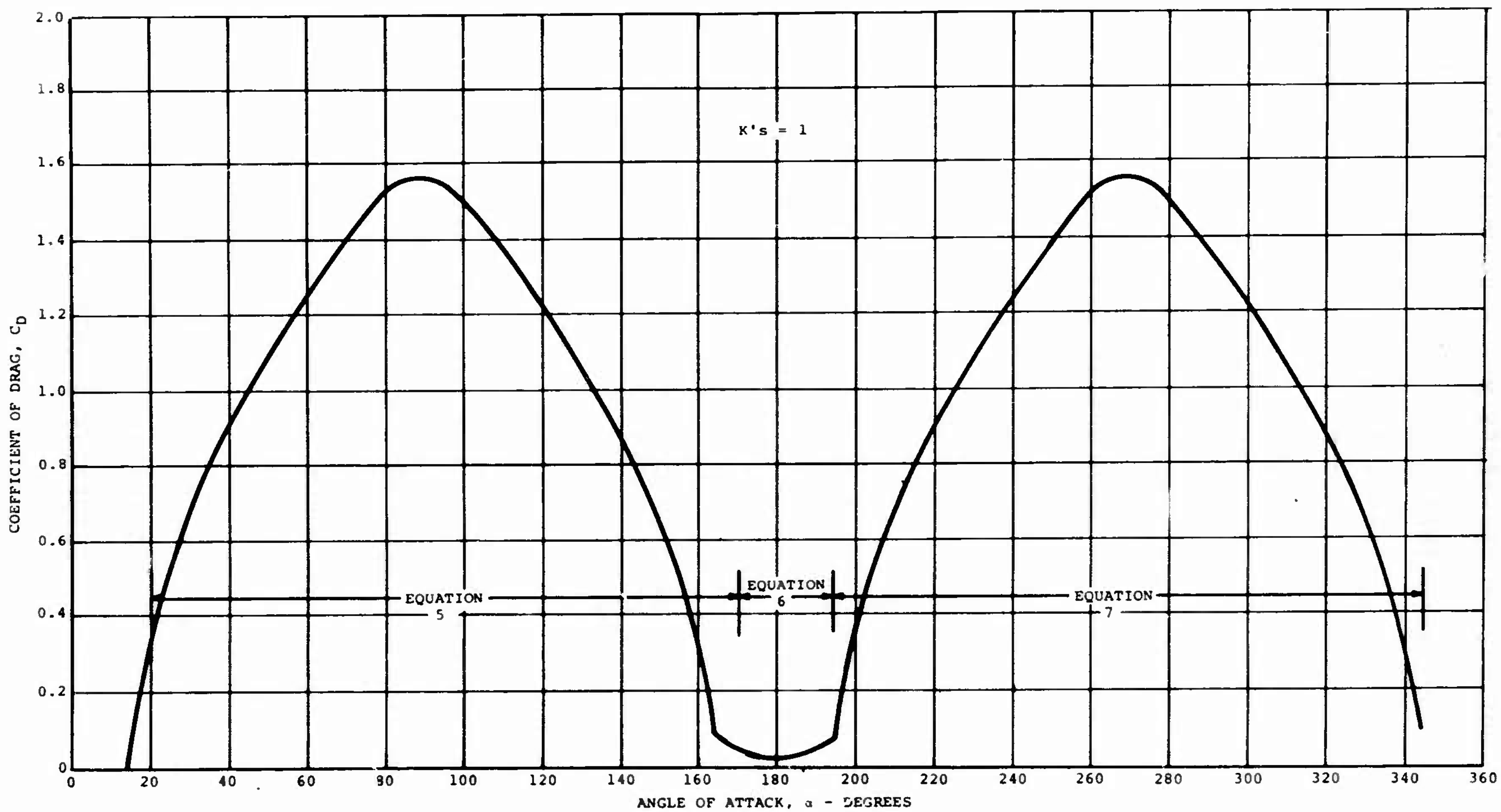


Figure 7. Section Drag Characteristics at Large Angles of Attack

(6) $C_D = 5.5012552 - 0.060345598 \times \delta + 0.00016618434 \times \delta^2$

where $\delta = \alpha$ for $166 < \alpha \leq 180°$

and $\delta = (360° - \alpha)$ for $180° < \alpha < 194°$

(7) $C_D = -1.0783242 + 0.10546602 \times \nu - 0.0022458297 \times \nu^2$

$+ 2.543888 \times 10^{-5} \times \nu^3 - 1.0989072 \times 10^{-7} \times \nu^4$

where $\nu = (\alpha - 180°)$ for $194° \leq \alpha < 270°$

and $\nu = 360° - \alpha - (345° - \alpha_{neg\ stall}) \left(\frac{\alpha - 270°}{\alpha_{neg\ stall} - 270°}\right)$

for $270° \leq \alpha < \alpha_{neg\ stall}$

Pitching Moment Coefficient Deck

Moderate α Range

For $-16° < \alpha < 16°$, tabulated data must be provided, as follows:

C_m at $\alpha = -16°$ (344°), one value
C_m at $\alpha = 16°$, one value

Up to 13 sets of C_m-Mach number pairs, corresponding to a set of up to 13 α's. Up to 10 pairs per set may be provided.

High α Range

The curve for C_m between $16° \leq x \leq 344°$ is presented in Figure 8 and the equations for the curve are given below. The first term in the equation for C_m between 16° and 30° and between 330° and 344° is zero for a symmetrical airfoil and not equal to zero for cambered airfoils.

The following are equations of line segments defining the airfoil pitching moment coefficient at large angles of attack:

(8) $16° < \alpha \leq 30°$ $\quad C_m = (C_{m16°} + 0.0955) \left(\frac{30 - \alpha}{14}\right) + (0.22140169$

$- 0.037698898 \times \alpha + 0.0014700305 \times \alpha^2$

$- 2.1980119 \times 10^{-5} \times \alpha^3)$

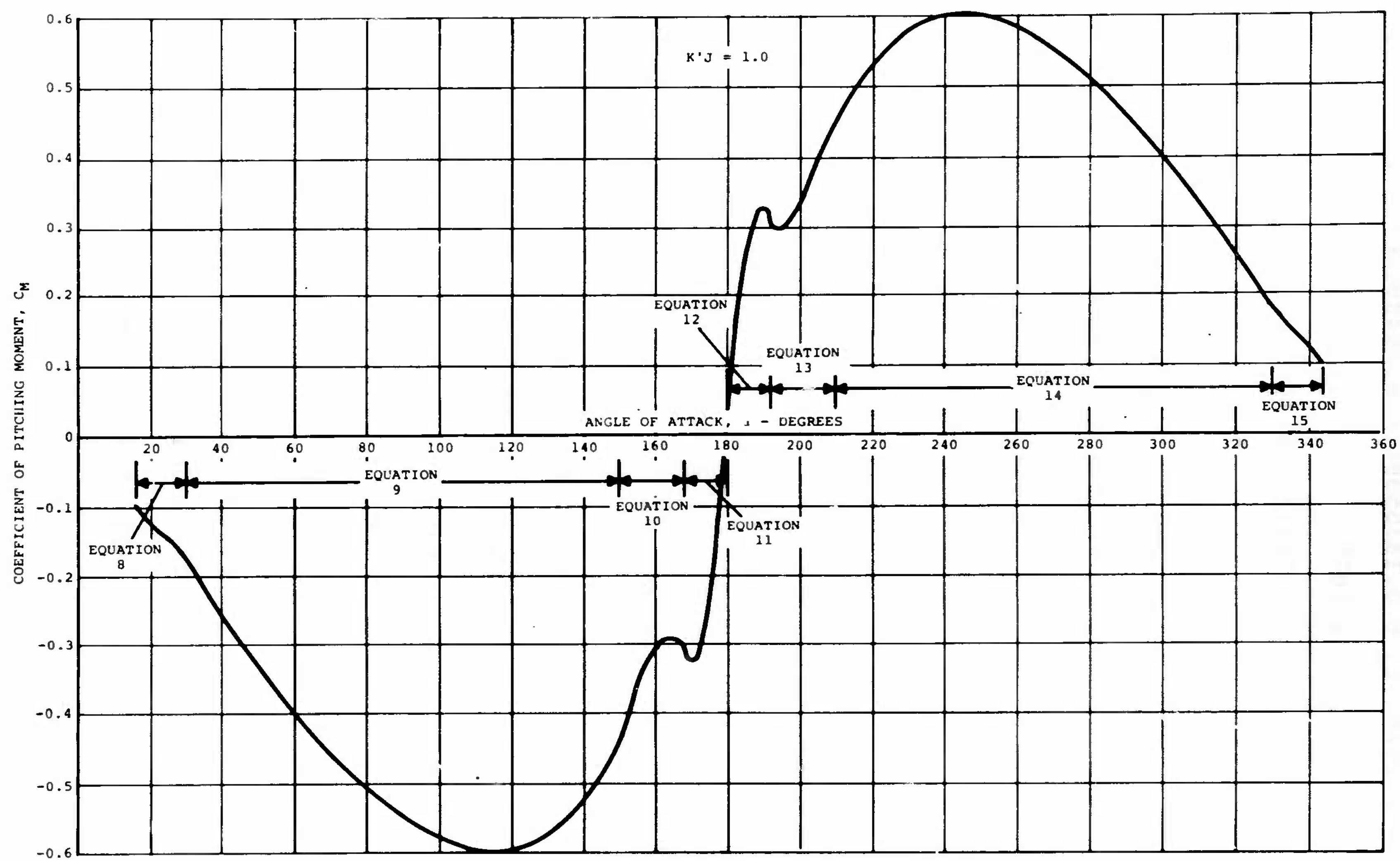


Figure 8. Section Pitching Moment Characteristics at Large Angles of Attack

(9) $30° < \alpha < 150°$ $C_m = 0.16285396 - 0.014395669 \times \alpha + 1.2695044 \times 10^{-4} \times \alpha^2 - 9.4724852 \times 10^{-7} \times \alpha^3 + 3.7413282 \times 10^{-9} \times \alpha^4$

(10) $150° < \alpha \leq 168°$ $C_m = (-9.8201326 + 0.051520593 \times \alpha + 4.2809828 \times 10^{-4} \times \alpha^2 - 2.3662806 \times 10^{-6} \times \alpha^3)$

(11) $168° < \alpha \leq 180°$ $C_m = 46.119316 - 0.42395661 \times \alpha + 0.0011007744 \times \alpha^2 - 6.7548054 \times 10^{-6} \times \alpha^3 + 3.2327550 \times 10^{-8} \times \alpha^4$

$\delta = 360° - \alpha$ and is applicable between 180° and 344°.

(12) $180° < \alpha \leq 192°$ $C_m = -46.119316 + 0.42395661 \times \delta - 0.0011007744 \times \delta^2 + 6.7548054 \times 10^{-6} \times \delta^3 - 3.2327550 \times 10^{-8} \times \delta^4$

(13) $192° \leq \alpha < 210°$ $C_m = 9.8201326 - 0.051520593\ \delta - 4.2809828 \times 10^{-4} \times \delta^2 + 2.3662806 \times 10^{-6} \times \delta^3$

(14) $210° \leq \alpha < 330°$ $C_m = -0.16285396 + 0.014395669\ \delta - 1.2695044 \times 10^{-4} \times \delta^2 + 9.4724852 \times 10^{-7} \times \delta^3 - 3.7413282 \times 10^{-9} \times \delta^4$

(15) $330° \leq \alpha < 344°$ $C_m = (C_{m344°} - 0.0955)\left(\frac{\alpha - 330}{14}\right) + (-0.2214069 + 0.037698898 \times \delta - 0.0014700305 \times \delta^2 + 2.1980119 \times 10^{-5} \times \delta^3)$

A typical C_L, C_D, and C_M airfoil deck is defined below. This example is shown only to indicate how to define the decks and is not meant to indicate actual airfoil data.

C_L Deck

Title Card

```
     180.        180.MAX POS ALPHA,MAX NEG ALPHA
    0.0        1.0000      1.0000      1.0000     1.0000CONTROL NOS.

        10 NO.OF MACH NUMBERS FOR CL VS ALPHA
          MACH NUMBERS
     0.0        0.300      0.400      0.550      0.650      0.750      0.800
     0.850      0.900      1.000
***********************  LIFT TABLE  ***********************************
    5 NM.OF ALPHA-CL PAIRS FOR MACH NUM. =     0.0
ALPHA
     0.0        6.00      20.000    340.000    360.000
CL
 -0.010000  0.640000  2.040000 -2.240000 -0.010000
    5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.300
ALPHA
     0.0        7.400     20.000    340.000    360.000
CL
 -0.020000  0.825000  2.146999 -2.219999 -0.020000
    5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.400
ALPHA
     0.0        6.500     20.000    340.000    360.000
CL
 -0.015000  0.755000  2.266999 -2.410000 -0.015000
    5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.550
ALPHA
     0.0        3.000     20.000    340.000    360.000
CL
 -0.025000  0.360000  2.485000 -2.525000 -0.025000
    6 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.650
ALPHA
     0.0        2.000      4.000     20.000    340.000    360.000
CL
 -0.020000  0.280000  0.555000  2.714999 -3.020000 -0.020000
    5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=     0.750
ALPHA
     0.0        1.000     20.000    340.000    360.000
CL
 -0.020000  0.160000  2.990000 -3.620000 -0.020000
    6 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.800
ALPHA
     0.0        1.200     20.000    340.000    358.800    360.000
CL
 -0.045000  0.225000  3.134999 -3.195000 -0.285000 -0.045000
    5 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.850
```

```
ALPHA
     0.0       3.600    20.000   340.000   360.000
CL
 -0.045000  0.795000  2.106999 -2.540000 -0.045000
    7 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      0.900
ALPHA
     0.0       1.200     6.200    20.000   340.000   358.900   360.000
CL
 -0.015000  0.075000  0.800000  1.766000 -1.480000 -0.095000 -0.015000
    4 NM.OF ALPHA-CL PAIRS FOR MACH NUM.=      1.000
ALPHA
     0.0      20.000   340.000   360.000
CL
 -0.010000  0.190000 -1.209999 -0.010000
```

C_D Deck

(No title card required, attached to C_L deck)

```
POS-NEG STALL ANGLES IN CD-M TABLES
    12.000   350.000
        14 NO.OF ALPHA VALUES FOR CD VS M
          ALPHA
     0.0       1.000     2.000     4.000     6.000     8.000    10.000
    12.000    14.000   350.000   357.000   358.000   359.000   360.000
    7 NUM OF M-CD PAIRS FOR ALPHA =      0.0
MACH
     0.0       0.400     0.700     0.810     0.840     0.877     1.000
CD
  0.011600  0.008600  0.009200  0.010100  0.014900  0.032800  0.105700
    7 NUM OF M-CD PAIRS FOR ALPHA =      1.000
MACH
    0.0        0.400     0.750     0.775     0.810     0.850     1.000
CD
  0.011600  0.008800  0.009300  0.010300  0.013900  0.024400  0.112700
    7 NUM  OF M-CD PAIRS FOR ALPHA =     2.000
MACH
    0.0        0.400     0.625     0.700     0.765     0.800     1.000
CD
  0.011600  0.008700  0.009100  0.010000  0.014000  0.023400  0.132200
    7 NUM OF M-CD PAIRS FOR ALPHA =      4.000
MACH
    0.0        0.300     0.625     0.675     0.725     0.800     1.000
CD
  0.011600  0.009200  0.011100  0.015300  0.029000  0.062900  0.202700
    7 NUM OF M-CD PAIRS FOR ALPHA =      6.000
MACH
    0.0        0.300     0.400     0.530     0.600     0.650     1.000
CD
  0.011600  0.009200  0.010550  0.013500  0.022100  0.043100  0.277700
    7 NUM OF M-CD PAIRS FOR ALPHA =      8.000
```

```
 MACH
      0.0       0.300     0.400     0.450     0.500     0.600     1.000
CD
  0.013700  0.011700  0.015800  0.022980  0.034300  0.080100  0.351200
    7 NUM OF M-CD PAIRS FOR ALPHA =     10.000
MACH
      0.0       0.200     0.250     0.300     0.350     0.400     1.000
CD
  0.018600  0.017400  0.017700  0.023200  0.034400  0.052700  0.427700
    7 NUM OF M-CD PAIRS FOR ALPHA =     12.000
MACH
      0.0       0.150     0.200     0.250     0.300     0.400     1.000
CD
  0.024600  0.024600  0.027400  0.038700  0.058200  0.114200  0.477500
    7 NUM OF M-CD PAIRS FOR ALPHA =     14.000
MACH
      0.0       0.100     0.125     0.150     0.175     0.200     1.000
CD
  0.031600  0.031600  0.032100  0.034600  0.038900  0.048900  0.533700
    7 NUM OF M-CD PAIRS FOR ALPHA =    350.000
MACH
      0.0       0.250     0.300     0.360     0.410     0.450     1.000
CD
  0.024100  0.022200  0.022400  0.025300  0.030800  0.040400  0.259500
    7 NUM of M-CD PAIRS FOR ALPHA =    357.000
MACH
      0.0       0.500     0.650     0.700     0.750     0.825     1.000
CD
  0.012100  0.008800  0.010600  0.016100  0.027000  0.053900  0.152700
    7 NUM OF M-CD PAIRS FOR ALPHA =    358.000
MACH
      0.0       0.400     0.700     0.750     0.800     0.825     1.000
CD
  0.011600  0.008700  0.010100  0.014500  0.025000  0.036400  0.137700
    7 NUM OF M-CD PAIRS FOR ALPHA =    359.000
MACH
      0.0       0.400     0.750     0.775     0.810     0.850     1.000
CD
  0.011600  0.008800  0.009300  0.010500  0.015400  0.025900  0.117700
    7 NUM OF M-CD PAIRS FOR ALPHA =    360.000
MACH
      0.0       0.400     0.700     0.810     0.840     0.877     1.000
CD
  0.011600  0.008600  0.009200  0.010120  0.014900  0.032800  0.105700
```

C_M DECK

```
CM ALPHA=16 DEG and 344 DEG
    -0.096      0.096
        15 NO.OF ALPHA VALUES FOR CM VS M
          ALPHA
     0.0         2.000      4.000      6.000      8.000     10.000     11.000
    13.000      16.000    344.000    349.000    352.000    356.000    359.000
   360.000
   10 NO.OF M-CM PAIRS FOR ALPHA =      0.0
MACH
     0.0         0.100      0.200      0.300      0.500      0.600      0.800
     0.900       0.950      1.000
CM
  0.0        0.0         0.0      0.0       0.0       0.0       0.0
  0.0       -0.001500 -0.002000
   10 NO.OF  -CM PAIRS FOR ALPHA =      2.000
MACH
     0.0         0.300      0.600      0.700      0.750      0.800      0.850
     0.900       0.950      1.000
CM
 -0.002000 -0.00]]00 -0.001000  0.000500  0.002200 -0.001200 -0.061000
 -0.049000 -0.035000 -0.039500
   10 NO.OF M-CM PAIRS FOR ALPHA =      4.000
MACH
     0.0         0.300      0.500      0.600      0.650      0.750      0.800
     0.850       0.900      1.000
CM
 -0.006000 -0.004800 -0.003000  0.003000  0.004000 -0.014000 -0.055500
 -0.072000 -0.049000 -0.012000
   10 NO.OF M-CM PAIRS FOR ALPHA =      6.000
MACH
     0.0         0.500      0.600      0.650      0.750      0.800      0.850
     0.900       0.925      1.000
CM
 -0.010000 -0.008000  0.001000  0.001500 -0.050000 -0.070000 -0.079000
 -0.071000 -0.046500 -0.080000
   10 NO.OF M-CM PAIRS FOR ALPHA =      8.000
MACH
     0.0         0.300      0.400      0.500      0.600      0.700      0.800
     0.900       0.925      1.000
CM
 -0.016000 -0.014000 -0.016500 -0.017000 -0.012000 -0.033500 -0.069000
 -0.077000 -0.056000 -0.077500
   10 NO.OF M-CM PAIRS FOR ALPHA =     10.000
MACH
     0.0         0.150      0.400      0.500      0.600      0.700      0.800
     0.900       0.925      1.000
```

```
CM
 -0.015000 -0.020000 -0.032000 -0.032000 -0.031000 -0.047000 -0.067500
 -0.078500 -0.057000 -0.074000
   10 NO.OF M-CM PAIRS FOR ALPHA =     11.000
MACH
      0.0         0.150      0.300      0.400      0.600      0.700      0.800
      0.900       0.925      1.000
CM
 -0.022500 -0.025500 -0.046500 -0.053000 -0.052500 -0.066000 -0.081000
 -0.092000 -0.073000 -0.086000
   10 NO.OF M-CM PAIRS FOR ALPHA =     13.000
MACH
      0.0         0.150      0.300      0.400      0.600      0.700      0.800
      0.900       0.925      1.000
CM
 -0.071000 -0.072000 -0.078000 -0.088000 -0.088000 -0.096500 -0.105500
 -0.112000 -0.099000 -0.105500
    2 NO.OF M-CM PAIRS FOR ALPHA =     16.000
MACH
      0.0         1.000
CM
 -0.096000 -0.096000
    2 NO. OF M-CM PAIRS FOR ALPHA =   344.000
MACH
      0.0         1.000
CM
  0.096000  0.096000
   10 NO.OF M-CM PAIRS FOR ALPHA =    349.000
MACH
      0.0         0.150      0.300      0.400      0.600      0.700      0.800
      0.900       0.925      1.000
CM
  0.022500  0.025500  0.046500  0.053000  0.052500  0.066000  0.081000
  0.092000  0.073000  0.086000
   10 NO.OF M-CM PAIRS FOR ALPHA =    352.000
MACH
      0.000       0.300      0.400      0.500      0.600      0.700      0.800
      0.900       0.925      1.000
CM
  0.016000  0.014000  0.016500  0.017000  0.012000  0.033500  0.069000
  0.077000  0.056000  0.077500
   10 NO.OF M-CM PAIRS FOR ALPHA =    356.000
```

```
MACH
     0.0        0.800      0.500      0.600      0.650      0.750      0.800
     0.850      0.900      1.000
CM
  0.006000  0.004800  0.003000 -0.003000 -0.004000  0.014000  0.055300
  0.072000  0.049000  0.012000
   10 NO.OF M-CM PAIRS FOR ALPHA =    359.000
MACH
     0.0        0.300      0.500      0.600      0.750      0.800      0.850
     0.900      0.950      1.000
CM
 -0.001000  0.001000 -0.001500 -0.003800  0.002000  0.000500  0.035000
  0.012500  0.010000  0.019000
   10 NO.OF M-CM PAIRS FOR ALPHA =    360.000
MACH
     0.0        0.100      0.200      0.300      0.500      0.600      0.800
     0.900      0.950      1.000
CM
  0.0       0.0       0.0       0.0       0.0       0.0       0.0
  0.0      -0.001500 -0.002000
```

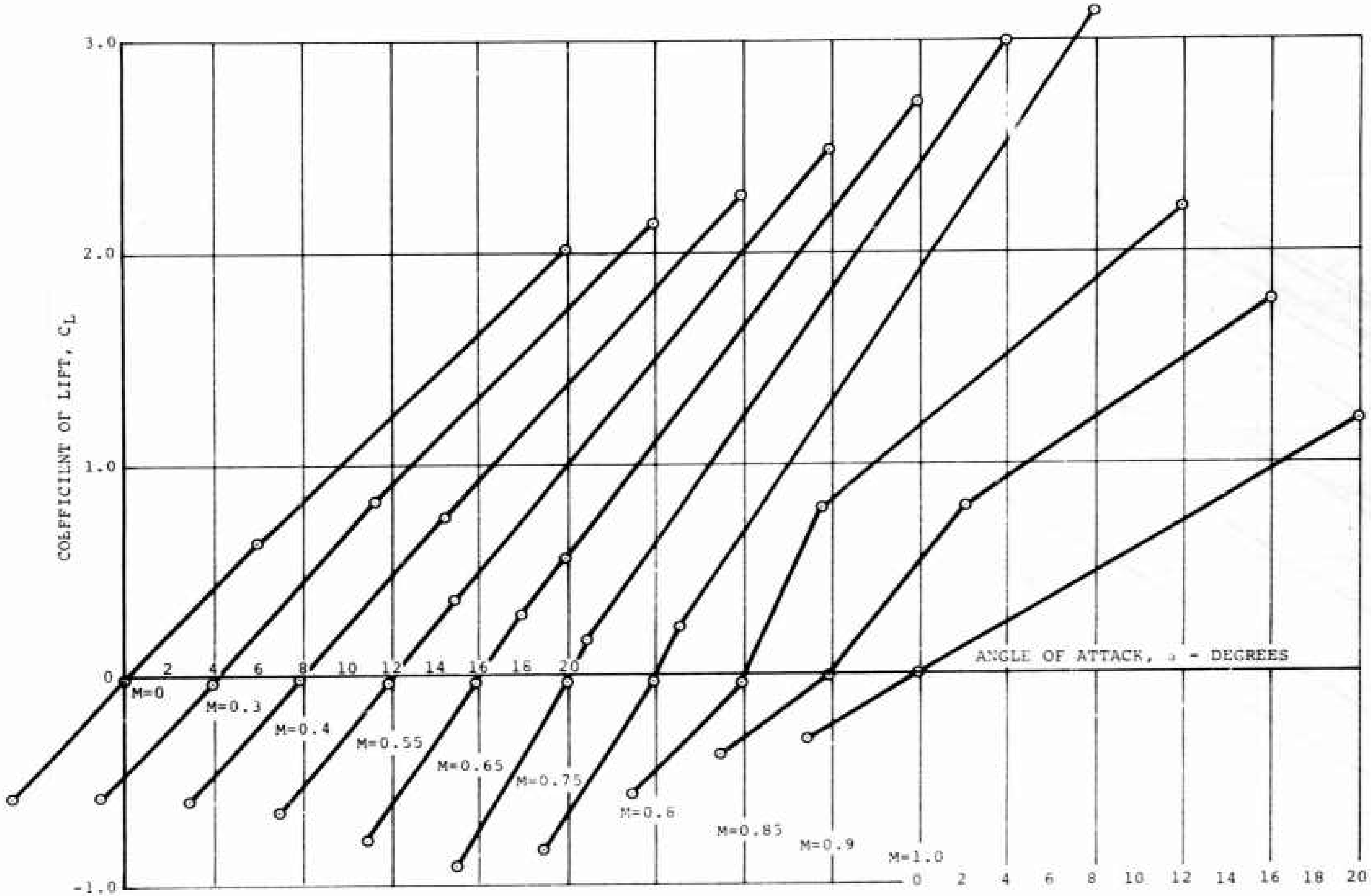


Figure 9. Coefficient of Lift for NACA 0011 (Mod) Airfoil Section

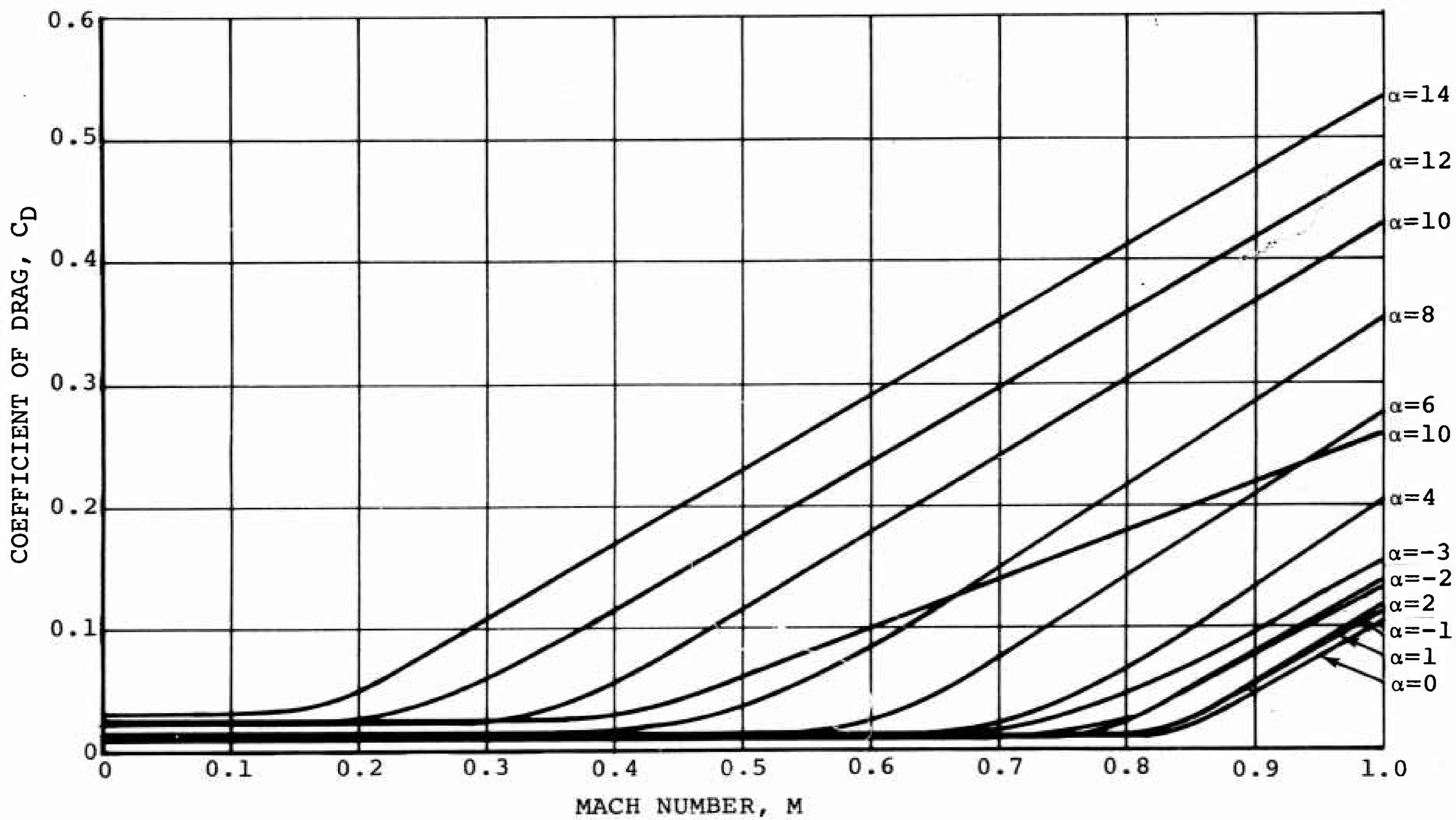


Figure 10. Coefficient of Drag for NACA 0011 (Mod) Airfoil Section

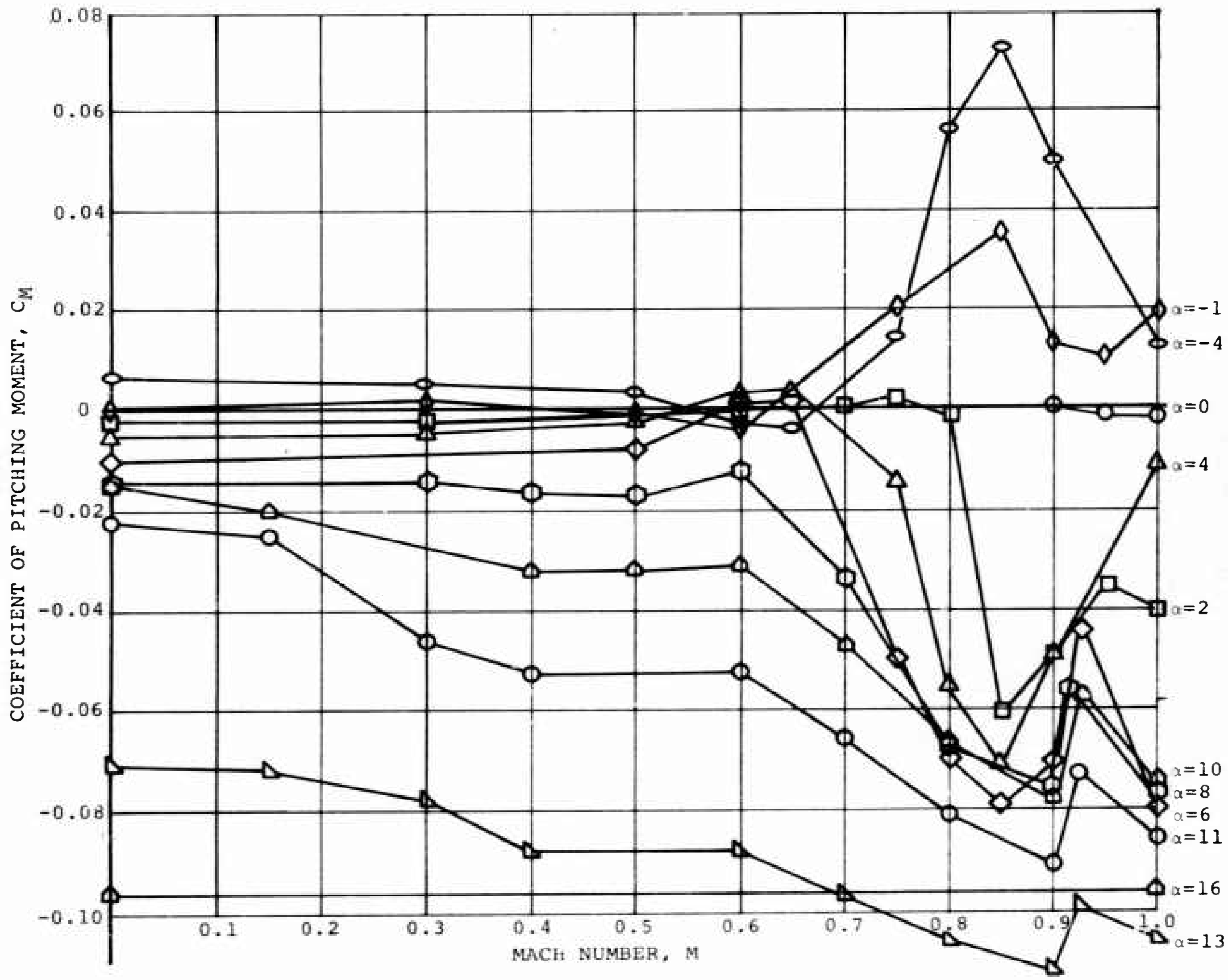


Figure 11. Coefficient of Pitching Moment for NACA 0011 (Mod) Airfoil Section

PROGRAM INPUT

Dimension Code N-D Nondimensional
SL Slug - mass unit = $Lb\text{-}Sec^2/Ft$

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
1	V	Flight path velocity (knots), TAS	kts
2	α	Fuselage water line angle of attack - measured from direction of free stream velocity, not horizon (positive nose up) - same units and sign convention as aero trim output.	deg
3	Ω	Rotor speed.	rpm
4	ρ	Air mass density.	sl/ft^3
5	S	Speed of sound, $S = 49.1\sqrt{459.6 + T}$ where T = Temperature in degrees F.	ft/sec
6	-	Not used	---

Locations 7 thru 13 define the thrust, collective, cyclic and flapping for the forward rotor. These locations are also used for an isolated rotor analysis (as in a single rotor helicopter). Aft rotor data (Locs. 15-21) are required when a forward rotor is being analyzed and non-uniform rotor interference downwash is considered (i.e., when Loc. 46 = 1, Loc. 92 = 0 or 3 and Loc. 93 = 3 or 2).

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
7	T_{of}	Thrust of the forward rotor along the rotor shaft. Same units and sign convention as aero trim output. T_{of} = TF in aero trim output, A97.	lbs
8	θ_{of}	Collective pitch angle for the forward rotor. Equal to the mean mechanical angle of attack at the 0.75 r/R radial position - measured from the disc plane (positive nose up). Same units and sign convention as aero trim program.	deg

ROTOR ANALYSIS PROGRAM C-70

TITLE

AIRFOIL TABLES

1	C_L	C_D	C_M
2	C_L	C_D	C_M
3	C_L	C_D	C_M
4	C_L	C_D	C_M
5	C_L	C_D	C_M

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.
V	1	TRIM A-97	KTS.	CONTROLS	46	A	ROTOR
α	2	TRIM A-97	DEG.		47	B	No. of blades
Ω	3	TRIM A-97	R.P.M.		48	10.	No. of iterations
ρ	4	TRIM A-97	SL/FT³		49	1.	Thrust Routine
S	5	TRIM A-97	FT/SEC		50	0.	Linear Aero
Forward Rotor				a_∞	51	5.73	α/RAD.
T_0	7	TRIM A-97	LBS.	T.L.	52	0	N.D.
θ_0	8	TRIM A-97	DEG.	Δ_L	53	0	RAD.
θ_{1C}	9	TRIM A-97	DEG.	Δ_M	54	0	RAD.
θ_{1S}	10	TRIM A-97	DEG.	A	55	0	
β_0	11	TRIM A-97	DEG.	FGC	56	0	
β_{1C}	12	TRIM A-97	DEG.	F	57	0	N.D.
β_{1S}	13	TRIM A-97	DEG.	G	58	0	N.D.
Aft Rotor				k	59	0	
T_0	15	TRIM A-97	LBS.	A.T.	60	0.0	DEG.
θ_0	16	TRIM A-97	DEG.	Γ	61	2.10.	
θ_{1C}	17	TRIM A-97	DEG.	g	62	32.2	FT/SEC²
θ_{1S}	18	TRIM A-97	DEG.	V_{OF}	63	0.	FT/SEC²
β_0	19	TRIM A-97	DEG.	V_{OF}	64	0.	FT/SEC²
β_{1C}	20	TRIM A-97	DEG.	CONTROLS	65	2.	Iteration Output
β_{1S}	21	TRIM A-97	DEG.		66	1.	Force Output
DEG.	22	0.0	2C		67	1.	Flap Output
	23	0.0	2S		68	1.	Lag Output
	24	0.0	3C		69	1.	Hub Load Output
	25	0.0	3S		70	0.	Hub Motion
	26	0.0	4C	ΔC_M N.D.	71	0.0	n=1
	27	0.0	4S		72	0.0	n=2
	28	0.0	5C		73	0.0	n=3
	29	0.0	5S		74	0.0	n=4
	30	0.0	6C		75	0.0	n=5
	31	0.0	6S		76	0.0	n=6
	32	0.0	7C		77	0.0	n=7
	33	0.0	7S		78	0.0	n=8
	34	0.0	8C		79	0.0	n=9
	35	0.0	8S		80	0.0	n=10
	36	0.0	9C		81	0.0	n=11
	37	0.0	9S		82	0.0	n=12
	38	0.0	10C		83	0.0	n=13
	39	0.0	10S		84	0.0	n=14
CONTROLS	40	0. 1.	r_c OPT.		85	0.0	n=15
	41	0. 1.	C_M OPT.		86	0.0	n=16
	42	0.	OPT.		87	0.0	n=17
	43	0.	SPRING MATRIX		88	0.0	n=18
	44	0.			89	0.0	n=19
	45	0.			90	0.0	n=20

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.
DOWNWASH CONTROLS	91	3	V_0 Calculation		136	0.0	
	92	*	NUD-UD ODT		137	0.0	
	93	*	N.U.D. TYPE		138	0.0	
	94	1.	Vortex TYPE		139	0.0	
	95	0.	Near Wake Iter		140	0.0	
	96	1.	F.W. Iter-SI		141	0.0	
	97	0.	F.W. Iter-RI		142	0.0	
	98	2.	Vortex Spiral		143	0.0	
	99	A	Inboard Vortex		144	0.0	
	100	1.0	Outboard Vortex	$\gamma_L^{(1)}$	145	A	M=0
	101	0.	V_t opt		146	A	.2
	102	0.	ā		147	A	.4
	103	90.			148	A	.6
	104	90.			149	A	.8
	105	1.			150	A	1.
	106	1.		$\gamma_M^{(1)}$	151	A	M=0
	107	0.			152	A	.2
	108	A			153	A	.4
	109	A			154	A	.6
	110	A			155	A	.8
	111	A			156	A	1.
	112	1.		$\gamma_L^{(2)}$	157	A	M=0
	113	1.			158	A	.2
	114	1.			159	A	.4
	115	1.			160	A	.6
DEG.	116	0.	2C		161	A	.8
	117	0.	2S		162	A	1.
	118	0.	3C	$\gamma_M^{(2)}$	163	A	M=0
	119	0.	3S		164	A	.2
	120	0.	4C		165	A	.4
	121	0.	4S		166	A	.6
	122	0.	5C		167	A	.8
	123	0.	5S		168	A	1.
	124	0.	6C	$\gamma_L^{(3)}$	169	A	M=0
	125	0.	6S		170	A	.2
	126	0.	7C		171	A	.4
	127	0.	7S		172	A	.6
	128	0.	8C		173	A	.8
	129	0.	8S		174	A	1.
	130	0.	9C	$\gamma_M^{(3)}$	175	A	M=0
	131	0.	9S		176	A	.2
	132	0.	10C		177	A	.4
	133	0.	10S		178	A	.6
B	134	0.	N.D.		179	A	.8
	135	0.			180	A	1.

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DIM.
	181	0.0			226	0.0	
	182	0.0			227	0.0	
	183	0.0			228	0.0	
	184	0.0			229	0.0	
	185	0.0			230	0.0	
	186	0.0			231	0.0	
	187	0.0			232	0.0	
	188	0.0			233	0.0	
	189	0.0			234	0.0	
	190	0.0			235	0.0	
	191	0.0			236	0.0	
	192	0.0			237	0.0	
	193	0.0			238	0.0	
	194	0.0			239	0.0	
	195	0.0			240	0.0	
	196	0.0			241	0.0	
	197	0.0			242	0.0	
	198	0.0			243	0.0	
	199	0.0			244	0.0	
	200	0.0			245	0.0	
	201	0.0			246	0.0	
	202	0.0			247	0.0	
	203	0.0			248	0.0	
	204	0.0			249	0.0	
	205	0.0			250	0.0	
	206	0.0			251	0.0	
	207	0.0			252	0.0	
	208	0.0			253	0.0	
	209	0.0			254	0.0	
	210	0.0			255	0.0	
TORS DAMPING COEF	211	0.0	C_{Z1}		256	0.0	
	212	0.0	C_{Z2}		257	0.0	
	213	0.0	C_{Z3}		258	0.0	
	214	0.0	C_{Z4}		259	0.0	
	215	0.0	C_{Z5}		260	0.0	
	216	0.0	C_{Z6}		261	0.0	
	217	0.0	C_{Z7}		262	0.0	
	218	0.0	C_{Z8}		263	0.0	
	219	0.0	C_{Z9}		264	0.0	
	220	0.0	C_{Z10}		265	0.0	
r_{R_1}	221	A		CD_1	266	0.0	
r_{R_2}	222	A		CD_2	267	0.0	
r_{R_3}	223	A		CD_3	268	0.0	
r_{R_4}	224	0.			269	0.0	
r_{R_5}	225	0.			270	0.0	

FORM 52171 (7 71)

A = See C-70 writeup B = Basic data * = User's decision

ROTOR ANALYSIS
PROGRAM C-70

TITLE

BLADE TITLE:

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE		DEF.	LOC.	VALUE	DEF.	LOC.	VALUE
R	271	B	FT.		316	B		361	A		406	A		451	D-01			496	D-01		541	D-01
C_o	272	B	IN.		317	B		362	A		407	A		452	D-01			497	D-01		542	D-01
NO. AERO	273	*			318	B		363	A		408	A		453	D-01			498	D-01		543	D-01
NO. MASS	274	*			319	B		364	A		409	A		454	D-01			499	D-01		544	D-01
FLAP BDRY	275	A			320	B		365	A		410	A		455	D-01			500	D-01		545	D-01
LAG BDRY	276	A			321	B		366	A		411	A		456	D-01			501	D-01		546	D-01
e_o	277	B	IN.		322	B		367	A		412	A		457	D-01			502	D-01		547	D-01
b	278	B	IN.		323	B		368	A		413	A		458	D-01			503	D-01		548	D-01
δ_3	279	B	DEG.		324	B		369	A		414	A		459	D-01			504	D-01		549	D-01
i_{FWD}	280	B	DEG.	C_n	325	B	$\Delta\theta_t$	370	A	ϵ_n	415	A		460	D-01			505	D-01		550	D-01
i_{AFT}	281	B	DEG.	C_o	326	B	DEG.	371	A	N.D.	416	A	GJ_N	461	D-01		EI_β	506	D-01	EI_ζ	551	D-01
$\Delta\ell/R$	282	B	N.D.		327	B		372	A		417	A		462	D-01			507	D-01		552	D-01
$\Delta h/R$	283	B	N.D.	N.D.	328	B		373	A		418	A	LB-IN²	463	D-01		LB-IN²	508	D-01	LB-IN²	553	D-01
K_β	284	B	LB-IN./RAD.		329	B		374	A		419	A		464	D-01			509	D-01		554	D-01
C_β	285	B	LB-IN-SEC/RAD.		330	B		375	A		420	A		465	D-01			510	D-01		555	D-01
K_ζ	286	B	LB-IN/RAD.		331	B		376	A		421	A		466	D-01			511	D-01		556	D-01
C_ζ	287	B	LB-IN-SEC/RAD.		332	B		377	A		422	A		467	D-01			512	D-01		557	D-01
q_θ	288	B	N.D.		333	B		378	A		423	A		468	D-01			513	D-01		558	D-01
q_T	289	B	N.D.		334	B		379	A		424	A		469	D-01			514	D-01		559	D-01
	290	A	i = 1		335	B		380	A		425	A		470	D-01			515	D-01		560	D-01
	291	A	i = 2		336	D-01		381	D-01		426	D-01		471	D-01			516	D-01		561	D-01
	292	A	i = 3		337	D-01		382	D-01		427	D-01		472	D-01			517	D-01		562	D-01
	293	A	i = 4		338	D-01		383	D-01		428	D-01		473	D-01			518	D-01		563	D-01
	294	A	i = 5		339	D-01		384	D-01		429	D-01		474	D-01			519	D-01		564	D-01
	295	A	i = 6		340	D-01		385	D-01		430	D-01		475	D-01			520	D-01		565	D-01
	296	A	i = 7		341	D-01		386	D-01		431	D-01	R_L	476	B	IN.		521	0.0		566	0.0
	297	A	i = 8		342	D-01		387	D-01		432	D-01	γ_L	477	B	DEG.		522	0.0		567	0.0
	298	A	i = 9		343	D-01		388	D-01		433	D-01	R_1	478	B	IN.		523	0.0		568	0.0
	299	A	i = 10		344	D-01		389	D-01		434	D-01	R_2	479	B	IN.		524	0.0		569	0.0
	300	A	i = 11		345	D-01		390	D-01		435	D-01	R_3	480	B	IN.		525	0.0		570	0.0
$\frac{X_i}{R}$	301	A	i = 12	m_n	346	D-01	Y_{on}	391	D-01	I_θ	436	D-01	R_4	481	B	IN.		526	0.0		571	0.0
	302	A	i = 13		347	D-01		392	D-01		437	D-01	γ_1	482	B	DEG.		527	0.0		572	0.0
N.D.	303	A	i = 14	LBS-SEC²/IN.	348	D-01	IN	393	D-01		438	D-01	γ_2	483	B	DEG.		528	0.0		573	0.0
	304	A	i = 15		349	D-01		394	D-01		439	D-01	γ_3	484	B	DEG.		529	0.0		574	0.0
	305	A	i = 16		350	D-01		395	D-01	LBS-SEC²-IN.	440	D-01	γ_4	485	B	DEG.		530	0.0		575	0.0
	306	A	i = 17		351	D-01		396	D-01		441	D-01	a	486	0.	DEG.		531	0.0		576	0.0
	307	A	i = 18		352	D-01		397	D-01		442	D-01	b	487	0.	DEG.		532	0.0		577	0.0
	308	A	i = 19		353	D-01		398	D-01		443	D-01	c	488	0.	DEG.		533	0.0		578	0.0
	309	A	i = 20		354	D-01		399	D-01		444	D-01	d	489	0.	DEG.		534	0.0		579	0.0
	310	A	i = 21		355	D-01		400	D-01		445	D-01	k_z	490	B	LB/IN.		535	0.0		580	0.0
	311	A	i = 22		356	D-01		401	D-01		446	D-01		491	0.			536	0.0		581	0.0
	312	A	i = 23		357	D-01		402	D-01		447	D-01		492	0.			537	0.0		582	0.0
	313	A	i = 24		358	D-01		403	D-01		448	D-01		493	0.			538	0.0		583	0.0
	314	A	i = 25		359	D-01		404	D-01		449	D-01		494	0.			539	0.0		584	0.0
	315	A	i = 26		360	D-01		405	D-01		450	D-01		495	0.			540	0.0		585	0.0

FORM 52172 (7/71)

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
		Note: Aero trim program A97 prints the collective angle at the blade's center of rotation, THEOF. Therefore θ_{of} = THEOF - [amount of blade twist from center of rotation to .75 r/R] or for linearly twisted blades $\theta_{of} = \text{THEOF} - 0.75\ \theta_t$ where θ_t is the blade's linear twist defined positive - nose down at the tip. Note: If thrust routine is used (Loc. 49 = 1, or 2) program will use θ_{of} as a starting point for thrust match. If thrust routine is not used (Loc. 49 = 0) the forward rotor collective is set at θ_{of}.	

First harmonic coefficients of control system pitch angle for the forward rotor (Locs. 9 & 10) - zero degree azimuth position is trail aft.

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
9	θ_{1cf}	Lateral cyclic pitch angle for the forward rotor - cosine coefficient of cyclic pitch (positive - nose up at $\psi = 0$). Same units and opposite sign convention as aero trim output. θ_{1cf} = -AICF in aero trim output, A97.	deg
10	θ_{1sf}	Longitudinal cyclic pitch angle for the forward rotor - sine coefficient of cyclic pitch (positive - nose up, at $\psi = 90$). Same units and opposite sign convention as aero trim output. θ_{1sf} = -BITF in aero trim output,A97. $\theta_f = \theta_{of} + \theta_{1cf} \sin\psi + \theta_{1sf} \cos\psi$.	
11	β_{of}	Coning angle of forward rotor - steady flapping angle (positive - tip up). Same units and sign convention as aero trim program.	deg

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
		β_{of} = AOF in aero trim output, A97.	

First harmonic coefficients of blade flapping angle for the forward rotor (Locs. 12 & 13). Zero degree azimuth position is trail aft.

12	β_{1cf}	Longitudinal flapping of the forward rotor - cosine coefficient of flapping (positive - tip up at $\psi = 0$). Same units and opposite sign convention as aero trim output. β_{1cf} = -AIF in aero trim output, A97.	deg
13	β_{1sf}	Lateral flapping of the forward rotor - sine coefficient of flapping (positive - tip up at $\psi = 90$). Same units and opposite sign convention as aero trim output. β_{1sf} = -BIF in aero trim output, A97. $\beta_f = \beta_{of} + \beta_{1cf} \cos \psi + \beta_{1sf} \sin \psi$	deg
14	-	Not used.	---

Locations 15 thru 21 define the thrust, collective, cyclic and flapping for the aft rotor. Forward rotor data (Locs. 7 - 13) are required when an aft rotor is being analyzed and non-uniform rotor interference downwash is considered (i.e., when Loc. 46 = 2, Loc. 92 = 0 or 3 and Loc. 93 = 2 or 3).

15	T_{oa}	Thrust of the aft rotor along the rotor shaft. Same units and sign convention as aero trim output. T_{oa} = TR in aero trim output, A97.	lbs
16	θ_{oa}	Collective pitch angle for the aft rotor. Equal to the mean mechanical angle of attack at the 0.75 r/R radial position - measured from the disc plane (positive nose up). Same units and sign convention as aero trim program.	deg

LOCATION	SYMBOL	DESCRIPTION	DIMENSION

Note: Aero trim program A97 prints the collective angle at the blade's center of rotation, THEOR. Therefore

θ_{oa} = THEOR - [amount of blade twist from center of rotation to .75 r/R]

or for linearly twisted blades

$\theta_{oa} = \text{THEOR} - 0.75\ \theta_t$

where θ_t is the blade's linear twist defined positive - nose down at the tip.

Note: If thrust routine is used (Loc. 49 = 1, or 2) program will use θ_{oa} as a starting point for thrust match. If thrust routine is not used (Loc. 49 = 0) the aft rotor collective is set at θ_{oa}.

First harmonic coefficients of control system pitch angle for the aft rotor (Locs. 17 & 18) - zero degree azimuth position is trail aft.

17	θ_{1ca}	Lateral cyclic pitch angle for the aft rotor - cosine coefficient of cyclic pitch (positive - nose up at $\psi = 0$). Same units and opposite sign convention as aero trim output. θ_{1ca} = -AICR in aero trim output, A97.	deg
18	θ_{1sa}	Longitudinal cyclic pitch angle for the aft rotor - sine coefficient of cyclic pitch (positive - nose up, at $\psi = 90$). Same units and opposite sign convention as aero trim output. θ_{1sa} = -BITR in aero trim output, A97. $\theta_a = \theta_{oa} + \theta_{1ca} \cos \psi + \theta_{1sa} \sin \psi$	deg

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
19	β_{oa}	Coning angle of aft rotor - steady flapping angle (positive - tip up). Same units and sign convention as aero trim program. β_{oa} = AOR in aero trim output, A97.	deg

First harmonic coefficients of blade flapping angle for the aft rotor (Locs. 20 & 21). Zero degree azimuth position is trail aft.

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
20	β_{1ca}	Longitudinal flapping of the aft rotor - cosine coefficient of flapping (positive - tip up at $\psi = 0$). Same units and opposite sign convention as aero trim output. β_{1ca} = -AIR in aero trim output, A97.	deg
21	β_{1sa}	Lateral flapping of the aft rotor - sine coefficient of flapping (positive - tip up at $\psi = 90$). Same units and opposite sign convention as aero trim output. β_{1sa} = -BIR in aero trim output, A97.	deg
22 to 39	θ_{2C} to θ_{10S}	Higher harmonic coefficients of control system pitch angle (positive - nose up).	deg

Higher harmonic control applied to forward rotor only when Loc. 46 = 1 and to aft rotor only when Loc. 42 = 2.

$$\theta = \sum_{k=2}^{10} (\theta_{kc} \cos k\psi + \theta_{ks} \sin k\psi)$$

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
40	$\dot{v}_A$ opt	Control for $\dot{v}_A$ term in $\dot{\alpha}_{BE}$ 0 = include $\dot{v}_A$ term 1 = omit $\dot{v}_A$ term	---

$\dot{v}_A$ option is used only with non-uniform downwash (Loc. 92 = 0, 1 or 3).

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
41	C_M opt	Control for C_M option 0 = use C_M ref 1 = use $\left(\frac{C_{Mref} - C_{M_{L=0}}}{C_{Lref}}\right) \bar{C}_L + C_{M_{L=0}}$	

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
42	Γ	Control for the calculation of zeroth lift-downwash iteration vortex circulation strengths, Γ_ψ	---

=0 use

$$\Gamma_\psi = \frac{K \sum_{i=1}^{b_n} L_{i\psi}}{\Omega R^2 \rho \, U_i \sum_{i=1}^{b_n} l_i}$$

=1 use

$$\Gamma_o = \frac{4\pi \, C_T}{bl(2-3\mu^2)}$$

$$\Gamma_{1c} = 0$$

$$\Gamma_{1s} = \frac{-6\pi\mu \, C_T}{bl(2-3\mu^2)}$$

=2 use

$$\Gamma_o = \frac{4\pi \, C_T}{bl(2-3\mu^2)}$$

$$\Gamma_{1c} = \frac{3 \, a_\infty \, C_o}{8R} \beta_{1s}$$

$$\Gamma_{1s} = -\left[\frac{3 \, a_\infty \, C_o}{4R(2-3\mu^2)} \beta_{1c} - \frac{6\pi\mu \, C_T}{bl(2-3\mu^2)}\right]$$

where $\Gamma_\psi = K(\Gamma_o + \Gamma_{1c} \cos\psi + \Gamma_{1s} \sin\psi)$ and

b_n = number of aerodynamic blade elements over which lift is averaged = Loc. 105 or Loc. 106 (depending on whether Γ_ψ for tip or root)

$L_{i\psi}$ = lift over the ith aerodynamic blade element at azimuth ψ

$U_{i\psi}$ = total velocity at the ith station at azimuth ψ

l_i = length of the ith aerodynamic blade element

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
		k = a constant factor = Loc. 108, Loc. 109, Loc. 110, or Loc. 111 depending on whether Γ_{ψ} is outboard or inboard or for the forward or aft rotor	
		bl = number of blades	
		β_{1c}, β_{1s} = 1st harmonic coefficients of flapping = Loc. 12 and 13 for forward rotor and Loc. 20 and 21 for an aft rotor	
44	H	Control to account for blade deflections resulting from bending-torsion coupling	
	= 0	Deflections are calculated without bending-torsion coupling applied	
	= 1 or 3	Torsional deflections resulting from incremental changes in blade torsion due to bending of the torsion axis are calculated and added to the pitch deflections. These deflections are proportional to $M_y M_z \left(\frac{1}{EI_{\xi}} - \frac{1}{EI_{\zeta}} \right)$ and hence are not present for a symmetric section	
	= 2 or 3	Incremental flap and lag deflections resulting from bending of the torsion axis and calculated and added to the blade deflections	
45	C_{ELA}	Control for equivalent linear aerodynamics	
	= 0	a_{∞} = Loc. 51 b_{∞} = 0	
	= 1	a_{∞} and b_{∞} are calculated from airload routine	

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
46	Rotor	1 = analyze forward rotor 2 = analyze aft rotor Set equal to 1 when analyzing an isolated rotor (as in a single rotor helicopter)	---
47	bl	Number of blades per rotor	---
48	---	Number of iterations between the airload and coupled flap pitch routines - input values from 0 to 10	---
49	---	Control for thrust routine option. 0 - do not perform a thrust routine 1 - perform a thrust routine. The smallest value of collective will be found. 2 - perform a thrust routine. Choose collective nearest the initial value of θ.	---
50	L.A.	Control for aerodynamic option 0 - use non-linear, compressible aerodynamics from table look up 1 - use linear aerodynamics where $C_L = a_\infty \alpha$ $C_D = .012 + \frac{\alpha^2 a_\infty{}^2 (.8)}{\pi (R/C_O)}$ $C_M = 0$	---
51	a_∞	Two dimensional lift curve slope. Set equal to 5.73	1/rad
52	T.L.	Tip loss - The ineffective length of the blade tip, non-dimensionalized by the blade radius Note: Be sure that this length does not exceed the length of the tip bay.	N.D.

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
53	Δ_L	Constant subtraction from $\Delta\alpha_L$ to reduce stall delay (negative values increase the stall delay)	rad
54	Δ_M	Constant subtraction from $\Delta\alpha_{CM}$ to reduce stall delay (negative values increase the stall delay)	rad
55	Λ	Yaw angle control 0 - calculate cos Λ 1 - set cos $\Lambda = 1$	---
56	FGC	Controls selection of F&G functions 0 - calculate F and G 1 - F = Loc. 57, G = Loc. 58	---
57	F	Constant value of F function, used when Loc. 56 = 1	N.D.
58	G	Constant value of G function, used when Loc. 56 = 1	N.D.
59	K	Controls calculation of reduced frequency 0, - Use $k = C_o\Omega/2V$ 1, - Use $k = C_o \sqrt{-\ddot{\theta}/\theta}\,/2V$	---
60	AT	Used to limit $\Delta\alpha$ (i.e., dynamic stall delay angle) in the unsteady aero routine 0, - Sets limit of π radians. Any other number, - Sets limit as defined by the input value.	deg
61	$\bar{L}$	Control to modify the slope used to calculate the $\bar{L}$ term. Set equal to 0, - slope is π 1, - use the equivalent slope i.e., $.5(C_{L_{REF}}-C_{LO})/(\alpha_{REF(L)}\cos\Lambda)$	---

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
		2, - use the local slope i.e., $(C_{L_{REF+.01}} - C_{L_{REF}})50$. 3, - use the local slope plus yawed flow, i.e., $(C_{L_{REF+.01}} - C_{L_{REF}})50/\cos\Lambda$ 4, - slope is zero	
62	g	Gravity acceleration. For 1g field use 32.2	$\frac{ft}{sec^2}$
63	V_{of}	Steady induced velocity of forward rotor, positive down. Used when Loc. 91 = 0 or 2	ft/sec
64	V_{oa}	Steady induced velocity of the aft rotor, positive down. Used when Loc. 91 = 0 or 1	---
65	---	Controls iteration output 0, - Only the final iteration will be printed 1, - All iterations will be printed 2, - Abbreviated output. The thrust routine, aerodynamic parameters and pitch link loads are printed out for each iteration, with complete printout for the last iteration	---

Note: If Loc. 65 = 1 (all iterations printed) then Locs. 66 and 67 will affect output in all iterations. If Loc. 65 = 0 or 2, then Loc. 66 and 67 will affect output for the last iteration only.

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
66	---	Controls airload and coriolis output. 0, - No output for these loads 1, - Complete output (airloads, coriolis, C_L and P) 2, - Only coriolis, C_L and P 3, - Only C_L and P 4, - Only airloads, C_L and P (P = airloads perpendicular to the chord)	
67	---	Not used Set = 1	---
68	---	Not used Set = 1	---
69	---	Control for hub load output 0, - No output 1, - Complete hub load output	
70	---	Not used	---
71 to 90	ΔC_M	Pitching moment coefficient correction applied at each aerodynamic blade element (from the tip to the cut-out) to account for trailing edge or tab bend. This term shifts the C_M vs α curve by the ΔC_M specified. A positive ΔC_M increases the nose up pitching moment.	---

Locations 91 to 115 control the type and magnitude of the downwash. When the non-uniform downwash is input, Loc. 92 = 1, from the table in Loc. 586 to Loc. 1065, or when uniform downwash is used, Loc. 92 = 2, then Loc. 93 to 115 have no effect and may be set equal to zero, except Loc. 94 which must be equal to 1.

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
91	Cal V_o (Table)	Option for the calculation of uniform downwash 0, - Obtain V_{of} and V_{oa} from input 1, - Calculate V_{of}, obtain V_{oa} from input 2, - Obtain V_{of} from input and calculate V_{oa} 3, - Calculate V_{of} and V_{oa}	---
92	Down Wash	Control specifying type of induced velocity to be used 0, - Calculate non-uniform downwash 1, - Input downwash from a table in Locs. 586 to 1065 2, - Uniform downwash only 3, - Calculate non-uniform downwash and add uniform downwash	---
93	D.W.	Controls type of non-uniform downwash used 1, - Self-induced downwash only (single rotor) 2, - Total downwash (=sum of self induced and rotor interference) 3, - Rotor interference downwash only	---
94	NODWLP	Control to determine detail of vortex structure for subsequent airload response iterations. 0, - Calculate far wake for 0 iteration only. Calculate 11 filament mid and near wake every iteration. 1, - Calculate downwash for tip and root vortex only, for the 0 iteration. 2, - Calculate far wake for 0 iterations only. Calculate 11 filament mid and near wake for 0 iterations only. 3, - Calculate far wake for every iteration. Calculate 11 filament mid and near wake for every iteration. Do not use. Set equal to 1.	---
95	NWI	Number of near wake iteration loops for the first to tenth iteration.	---

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
95(Cont.)		**Note:** If equal to zero, the near wake iteration loops may be performed for the zero flap-pitch iteration only. Do not use. Set equal to zero.	
96	LOOPSI	Number of lift-downwash compatibility iterations for self-induced downwash. Minus one. Do not exceed 10.	
97	LOOPRI	Number of lift-downwash compatibility iterations for rotor interference downwash. Do not exceed 10.	---
98	M	Length of trailed vortex used in non-uniform downwash calculations, expressed in rotor revolutions. $M = (2 + \Delta 1/R)/2\pi\mu$ where $\frac{\Delta 1}{R}$ = Loc. 282 for tandem rotors $\frac{\Delta 1}{R} = 0$ for single rotor Note: Enter the value of M obtained from the above equation raised to the next higher 1/10. Example: Calculate M = 1.62 Use Loc. 98 = 1.7 Do not use values of M larger than 2.0	N-D
99	a_i	Distance from center line of hub to inboard trailed vortex, non-dimensional w.r.t. blade radius.	N-D
100	a_o	Distance from center line of hub to outboard trailed vortex, non-dimensional w.r.t. blade radius.	N-D
101	V_t	Tangential and radial velocity option. If control equals 0, - Omit tangential and radial velocity components 1, - Include tangential and radial component of the downwash in the airload calculations.	---

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
102	$\bar{a}$	Not used Set = 0	
103	DAMPSI	Damping factor applied to vortex circulation strengths, $\Gamma\psi$, to speed convergence of lift-downwash iterations for the self-induced downwash. Set equal to 90 (défined as a percent).	pct
104	DAMPRI	Damping factor applied to vortex circulation strengths, $\Gamma\psi$, to speed convergence of lift-downwash iterations for the rotor interference downwash. Set equal to 90 (defined as a percent). Example: DAMPRI = 90. means 0.1 of the change in circulation strength, $\Gamma\psi$, will be added to the previous Γ.	pct

$$\underset{\text{damping}}{\underset{\text{after}}{\Gamma(n+1)}} \quad \underset{\text{damping}}{\underset{\text{after}}{\Gamma n}} + 0.1 \times \left[\underset{\text{damping}}{\underset{\text{before}}{\Gamma n+1}} - \underset{\text{damping}}{\underset{\text{after}}{\Gamma n}} \right]$$

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
105	b_T	Number of outboard aerodynamic blade elements which the lift is averaged to determine the outboard vortex circulation strength.	---
106	b_R	Number of inboard aerodynamic blade elements over which the lift is averaged to determine inboard trailed vortex circulation strength.	---
107	PRTEST	Control to limit non-uniform downwash to a maximum value of $.1R\Omega$. 0, - Apply $.1R\Omega$ limit to downwash 1, - Do not apply limit	---
108	XKINTF	Factor applied to outboard vortex circulation strength, $\Gamma\psi$, in the zeroth lift - downwash iteration of the forward rotor.	---

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
109	XKINTRF	Factor applied to inboard vortex circulation strength, $\Gamma\psi$, in the zeroth lift-down-wash iteration for the forward rotor.	---
110	XKINTA	Factor applied to outboard vortex circulation strength $\Gamma\psi$, in the zeroth lift-vortex downwash iterations for the aft rotor.	---
111	XKINRA	Factor applied to inboard vortex circulation strength, $\Gamma\psi$, in the zeroth lift-vortex-downwash iteration for the aft rotor. Note: When location 108 and 111 are set equal to 0, the program sets the value at .1. If any other value is desired, simply put the value into the proper location. See Figures 12 and 13.	---
112	K_{TF}	Multiplication factor to modify outboard vortex circulation strength for the forward rotor.	---
113	K_{RF}	Multiplication factor to modify inboard vortex circulation strength for the forward rotor.	---
114	K_{TS}	Multiplication factor to modify outboard vortex circulation strength for the aft rotor.	---
115	K_{RS}	Multiplication factor to modify inboard vortex circulation strength for the aft rotor. If non-uniform downwash is calculated (Loc. 92 = 0 or 3) do <u>not</u> set Locs. 112 to Loc. 115 equal to zero. Doing so will zero out the non-uniform downwash.	---
116 to 133	β_{kc} β_{ks}	Second through tenth harmonic flap angle (positive - tip up) Loc. 116 = β_{2c} Loc. 117 = β_{2s} Loc. 118 = β_{3c} Loc. 119 = β_{3s}, etc.	deg

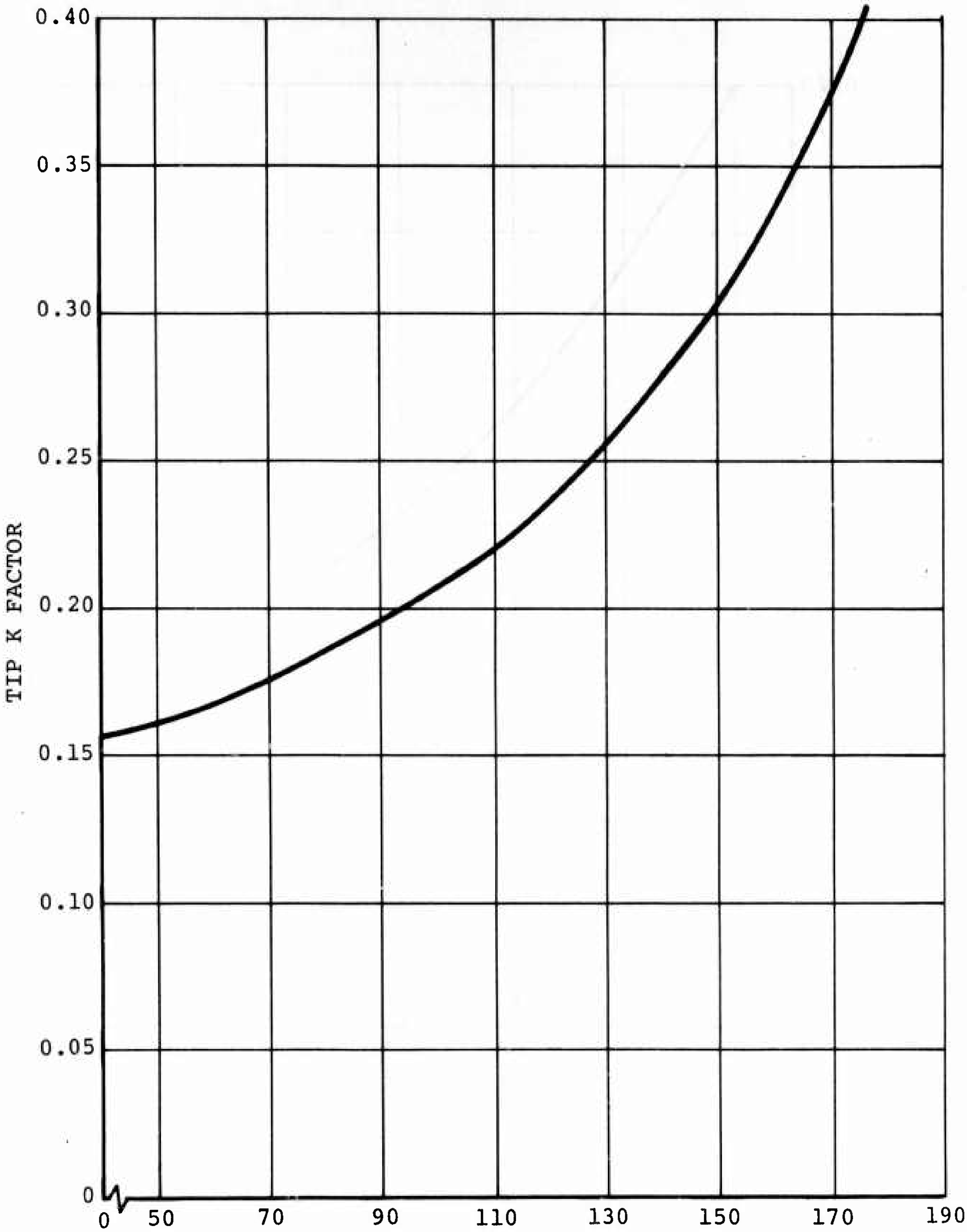


Figure 12. Circulation Strength Factor at Blade Tip

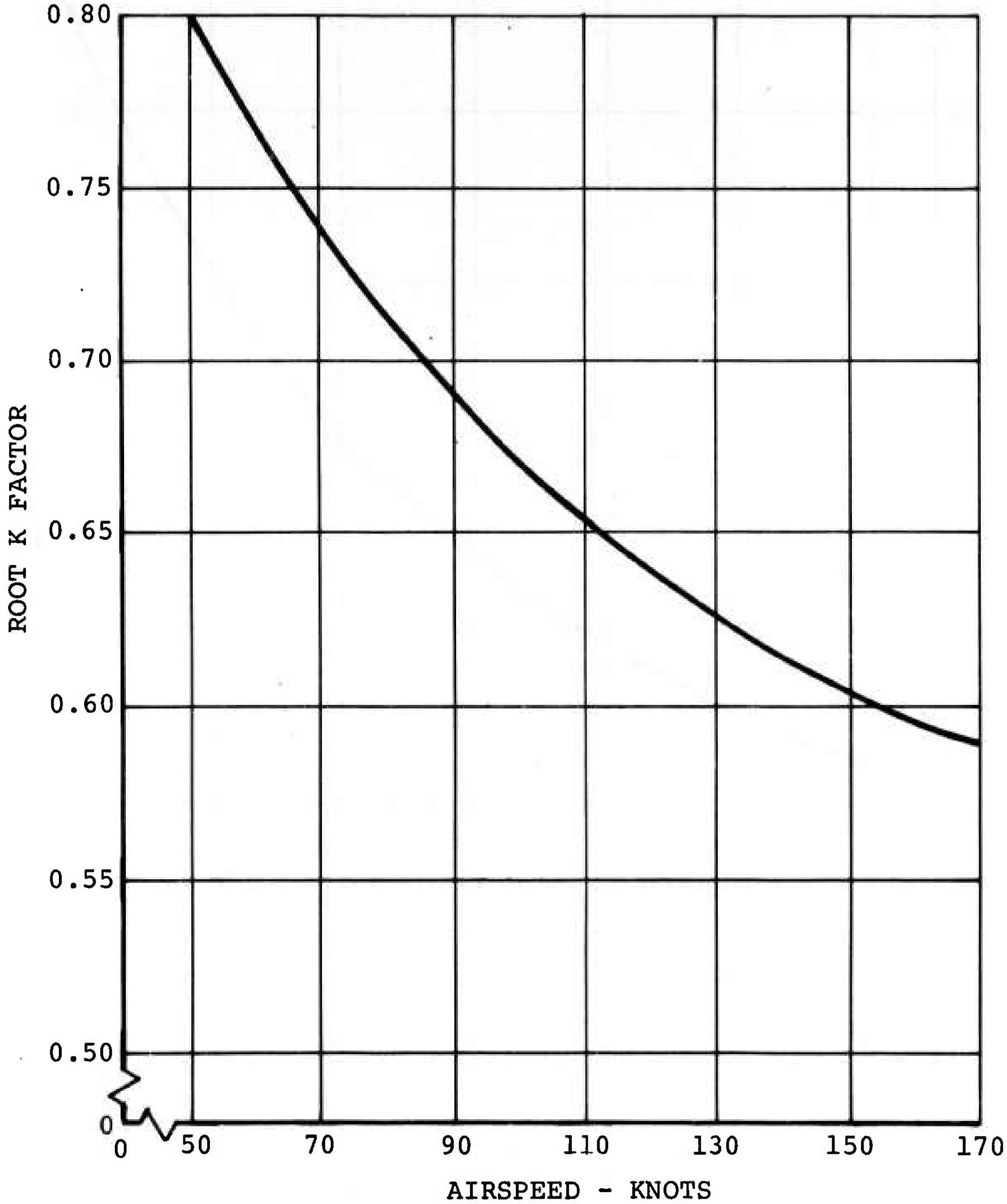


Figure 13. Circulation Strength Factor at Blade Root

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
116 to 133 (Continued)		Note: Use these locations only when Loc. 275 = 8 or 9. The steady (coning) and first harmonic are defined in Locs. 11, 12 and 13 for a forward rotor and in Locs. 19, 20, 21 for an aft rotor. The higher harmonic flapping coefficients are only applied to the rotor being analyzed; i.e., forward rotor when Loc. 46 = 1 and aft rotor when Loc. 46 = 2.	
134	ξ_o	Pre-lag angle	deg
135	α_V	Angle between forward speed and horizontal plane; positive when aircraft is climbing	deg
136 to 140	---	Free	---
141	K	Forced convergence factor used to speed convergence of airloads response iterations $D'_N = D_N + (D'_{N-1} - D_N) K$ where D'_N = displacement used to calculate N + 1 iteration airloads D_N = displacement based on Nth iteration airloads D'_{N-1} = displacements used to calculate Nth iteration airloads When K = 1 forced convergence is not employed	---
142	F	Damping factor - the factor (1 + F) is applied to the aero pitch damping in the force matrix. This factor is used to speed convergence.	---
143, 144	--	Free	---

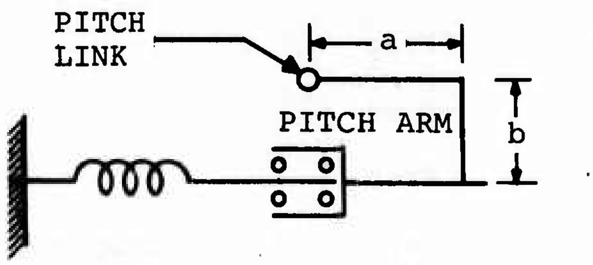
LOCATION	SYMBOL	DESCRIPTION	DIMENSION
145 to 150	$\gamma_L^{(1)}$	Lift γ function values of first airfoil table (most inboard) for Mach numbers from 0 to 1.	N.D.
151 to 156	$\gamma_M^{(1)}$	Moment γ function values of first airfoil table (most inboard) for Mach numbers from 0 to 1.	N.D.
157 to 162	$\gamma_L^{(2)}$	Lift γ function values of second airfoil table for Mach numbers from 0 to 1.	N.D.
163 to 168	$\gamma_M^{(2)}$	Moment γ function values of second airfoil table for Mach numbers from 0 to 1.	N.D.
169 to 174	$\gamma_L^{(3)}$	Lift γ function values of third airfoil table (most outboard) for Mach numbers from 0 to 1.	N.D.
175 to 180	$\gamma_M^{(3)}$	Moment γ function values of third airfoil table (most outboard) for Mach numbers from 0 to 1.	N.D.
181 to 210	---	Free	---
211 to 220	---	Free	---

C-70 has the capability of analyzing blades with non-constant airfoil sections. This is done by specifying up to 3 airfoil tables and the radial positions at which they apply. The program performs the double table lookup for each airfoil table and then linearly interpolates to obtain the coefficients for the aerodynamic blade elements in the intermediate positions. If a single airfoil section is used or if linear aerodynamics is used (Loc. 50 = 1) set Loc. 221 to 223 = 0.

221	$\frac{k_1}{R}$	Radial position at which most inboard airfoil table is applied. Set equal to r/R of cutout.	N.D.
222	$\frac{k_2}{R}$	Radial position at which second airfoil table is applied.	N.D.
223	$\frac{k_3}{R}$	Radial position at which most outboard airfoil table is applied. Set equal to 1.	N.D.

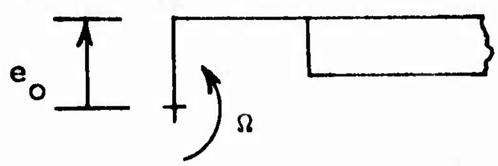
LOCATION	SYMBOL	DESCRIPTION	DIMENSION
		Enter the airfoil tables corresponding to these radial positions in boxes at the top of input sheet No. 1	
224	--	Free	---
225	--	Free	---
226 to 265	--	Free	---
266 267 268	ΔC_{D1} ΔC_{D2} ΔC_{D3}	Increments of drag coefficient which are added to drag coefficient obtained in double table lookup. ΔC_{D1} applies to the most outboard table, ΔC_{D2} to the second table, etc. Note: The ΔC_D's are added to the drag coefficients before any interpolation is performed for aerodynamic blade elements between the positions where the tables are applied (Locs. 221 to 223).	---
269	--	Free	---
270	--	Free	---
271	R	Blade radius	ft.
272	C_o	Reference chord	in.
273	N.A.	Number of aerodynamic blade elements (up to 20)	N.D.
274	N.M.	Total number of blade elements (up to 20)	N.D.
275	F.B.B.	Blade boundary control	---
	=1	Rigid blade	
	=2	Articulated blade - pitch housing between flap and lag hinge - flap hinge inboard	
	=3	Articulated blade - pitch housing outboard of lag hinge - flap hinge inboard	

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
276	a	Distance from pitch arm to pitch link	in.

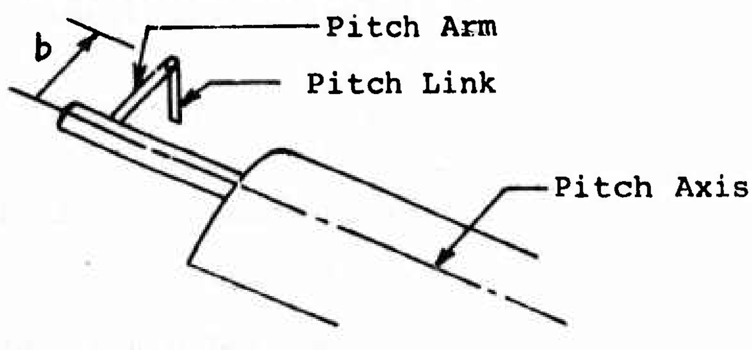


Positive toward center of rotation

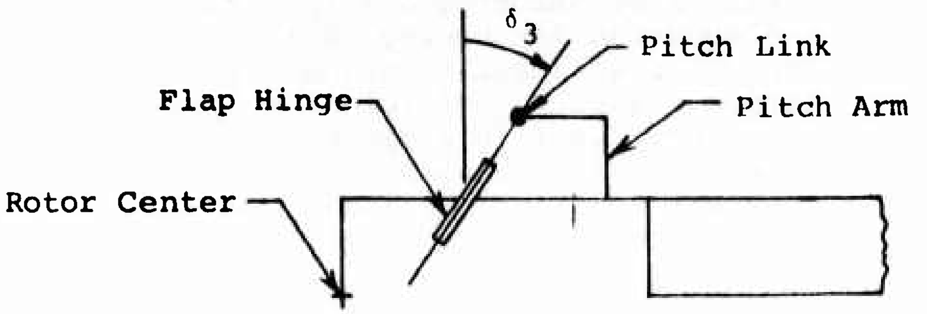
277	e_o	Horizontal hub offset (positive in the direction of rotation).	in.



278	b	Pitch arm, measured perpendicular to the pitch axis from the pitch axis to the pitch link (positive in the direction of rotation).	in.



LOCATION	SYMBOL	DESCRIPTION	DIMENSION
279	δ_3	Flap-pitch coupling angle - angle through which the "flap" hinge is rotated.	deg



LOCATION	SYMBOL	DESCRIPTION	DIMENSION
280	i_{fwd}	Shaft tilt of forward rotor-positive tilted forward	deg
281	i_{aft}	Shaft tilt of aft rotor-positive tilted forward	
282	$\Delta \ell/R$	Longitudinal distance between rotors, non-dimensional with respect to blade radius	N.D.
283	$\Delta h/R$	Vertical distance between rotors, non-dimensional with respect to blade radius measured from forward rotor to aft rotor, positive up	N.D.
284	k_β	Equivalent flap spring	lb-in/rad
285	C_β	Equivalent flap viscous damping	$\frac{\text{lb-in-sec}}{\text{rad}}$
286	K_ζ	Lag spring rate	$\frac{\text{lb-in}}{\text{rad}}$
287	C_ζ	Equivalent lag torsional damping coefficient	$\frac{\text{lb-in-sec}}{\text{rad}}$

$$C_\zeta = \frac{4\ Mp}{\pi \omega \zeta_{max}} + \bar{C}$$

where $\bar{C}$ viscous torsional damping rate in $\frac{\text{in-lb-sec}}{\text{rad}}$

M_p pre load moment in damper in-lb

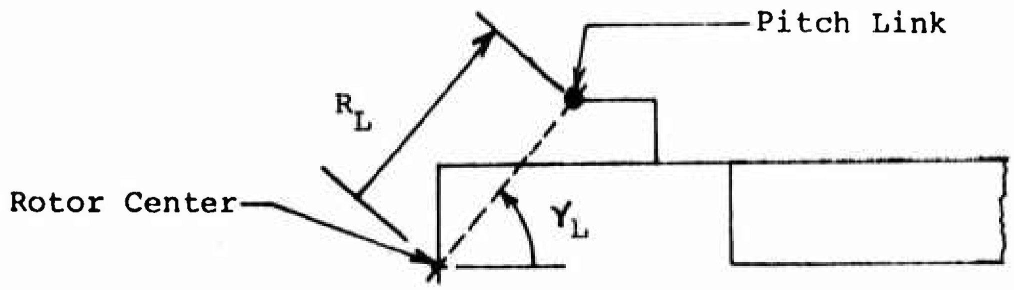
ω lag natural frequency rad/sec

ζ_{max} amplitude of lagging motion radians

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
287 (Cont'd)		Note: The above relation was obtained by assuming $\zeta = \zeta_{max} \sin \omega t$ and equating the energy lost in one cycle for an ideal torsional viscous damper (damping coefficient = C_ζ) to the energy lost in 1 cycle for a torsional viscous damper with a constant coulomb (pre load) damper of M_p superimposed and solving for C_ζ.	
288, 289	---	Not used	---
290-315	$\frac{x_i}{R}$	Distance from rotor center to blade element boundaries non-dimensionalized by blade radius, Loc. 271. Any number of boundaries may be used up to a maximum of 21; i.e., maximum of 20 elements. Location of boundaries must satisfy the following conditions: -Must have a boundary at blade tip; i.e., Loc. 290 = 1. -Must have boundary at cutout. -Must have boundary at flap hinge which is innermost boundary. For a teetering rotor flap hinge at x/R = 0. -Must have boundary at lag hinge which is adjacent to flap hinge. -Number of blade elements between blade tip and cutout must equal value in Loc. 273. -Total number of blade elements must equal value in Loc. 274.	
316-330	C_n/C_o	Blade chord non-dimensionalized by reference chord, Loc. 272.	N.D.
331-335	---	Free	---

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
336-360	M_n	Lumped blade element masses for each blade element starting from the blade tip. Must have a number of entries equal to value in Loc. 274.	
361-380	$\Delta\theta_{tn}$	Incremental blade twist between masses (masses are located at centers of blade elements). $\Delta\theta_{tn} = \theta_{t(n+1)} - \theta_{tn}$ where θ_{tn} is the built in twist angle at the nth mass measured from the disc plane in degrees, positive nose up. Only masses on the airfoil portion of the blade are considered; therefore, n ranges from 1 to (NA-1) where NA = Loc. 273. The last $\Delta\theta_{tn}$; i.e., $\Delta\theta_{t(NA)}$ is defined as $\Delta\theta_{t(NA)} = \theta_{t(.75)} - \theta_{t(NA)}$ where $\theta_{t(.75)}$ and $\theta_{t(NA)}$ are the built in twist angles at the .75 r/R and NAth mass respectively.	
381-405	Y_{on}	Distance from the pitch axis to the mass center of gravity (positive towards the trailing edge) for each blade element, starting from the blade tip.	in.
406-420	ε_n	Distance from mid-chord to the pitch axis (positive-forward) for each aerodynamic blade element, starting from the blade tip. Normalized by blade element chord, C_n. C_n = Loc. 316 to Loc. 335 x Loc. 272	N.D.
421-425	--	Free	---
426-450	I_{θ_n}	Blade pitch inertia about the pitch axis, for each blade element starting from the blade tip.	lbs-sec-in
451-475	GJ_n	Torsional rigidity between masses. When set equal to 0, the GJ is assumed infinite.	$lb\text{-}in^2$

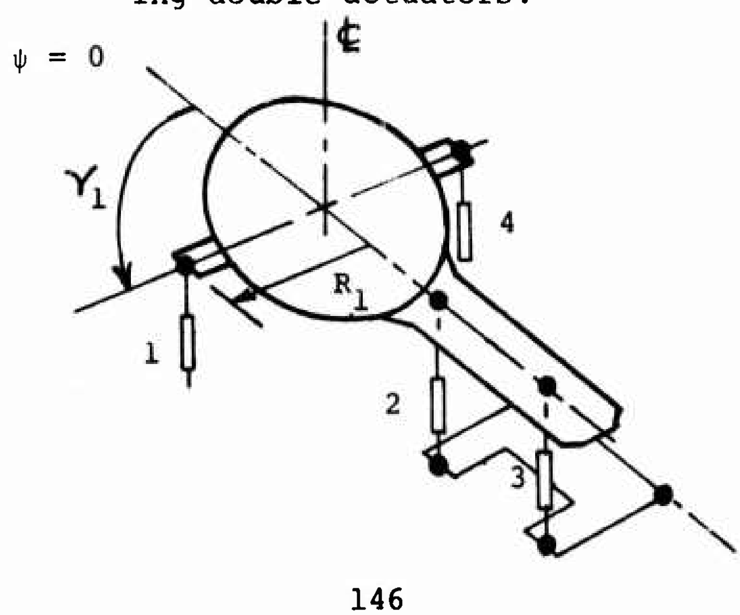
LOCATION	SYMBOL	DESCRIPTION	DIMENSION
476	R_L	Radial distance to the pitch link, measured from the center of rotation.	in.
477	γ_L	Angular displacement of the pitch link relative to the blade azimuth position, positive in the direction of rotation.	deg



LOCATION	SYMBOL	DESCRIPTION	DIMENSION
478-481	R_1, R_2, R_3, R_4	Radial distance to fixed system control actuators, measured from center of rotation.	in.
482-485	γ_1, γ_2, γ_3, γ_4	Azimuth position of the fixed system control actuators.	deg

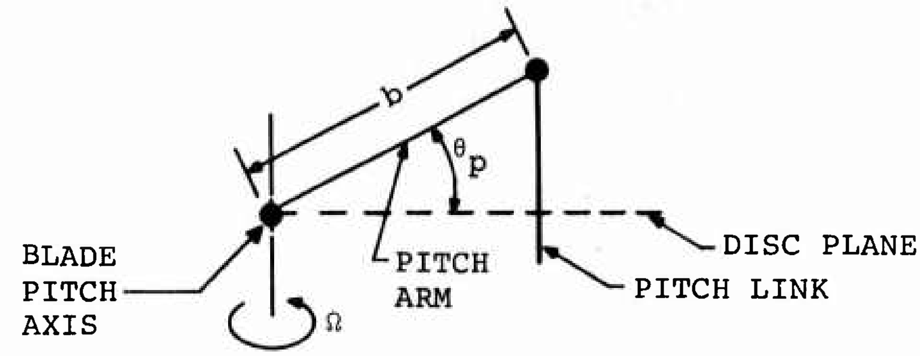
Note: Loc. 481 and 485 are used only for a 4 actuator control system, with pivoting double actuators. If both locations are zero, a three actuator fixed control system is assumed.

When the 4 actuator system is analyzed, 1 and 4 are the single actuators, 2 and 3 are the pivoting double actuators.

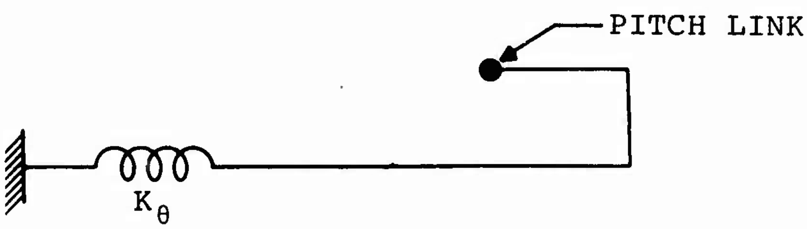


LOCATION	SYMBOL	DESCRIPTION	DIMENSION
486,487	a, b	Parameters used to expand the region of detailed aerodynamic coefficients defined in the short form C_L airfoil deck. a - is the low angle of attack limit (tables currently stop at 20 degrees). b - is the high angle of attack limit (tables currently stop at 340 (-20) degrees). Note: Detailed C_L are currently defined from α = 340 (-20) to 20 degrees. The airfoil deck must be expanded to include the new limits, but the maximum number of data points in the table may not be exceeded.	deg
488, 489	c, d	Parameters used to expand the region of detailed aerodynamic coefficients defined in the short form C_M airfoil deck. c - is the low angle of attack limit (tables currently stop at 16 degrees). d - is the high angle of attack limit (tables currently stop at 344 (-16) degrees). Note: Detailed C_M are currently defined from α = 344 (-16) to 16 degrees. The airfoil deck must be expanded to include the new limits, but the maximum number of data points in the table may not be exceeded.	deg
490	K_Z	Control system spring rate. When set equal to zero, K_Z is assumed infinite.	lb/in

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
491	θ_p	Angle between the pitch arm and the disc plane for zero collective at $r/R = 0.75$ - positive nose up	deg



LOCATION	SYMBOL	DESCRIPTION	DIMENSION
492	K_θ	Stiffness of torsional spring between pitch housing and hub	in.-lb/rad



LOCATION	SYMBOL	DESCRIPTION	DIMENSION
493	C_θ	Torsional root damper	$\frac{\text{in-lb-sec}}{\text{rad}}$
494	l_θ	Distance from root boundary to pitch bearing	in
495	---	Not used	---
496-520	$EI_{\beta n}$	Flapwise bending rigidity between masses. When set equal to 0, the EI is assumed infinite.	lb-in^2
521-540	$\bar{e}$	Distance from pitch axis to elastic axis - positive toward trailing edge	in
541-565	$EI_{\zeta n}$	Lagwise bending rigidity. When set equal to 0, the EI is assumed infinite.	lb-in^2

LOCATION	SYMBOL	DESCRIPTION	DIMENSION
566-585	$\bar{\bar{e}}_n$	Distance from pitch axis to vertical neutral axis - positive toward trailing edge	in
586-1065	$\frac{v}{R\Omega}$	Input array for externally calculated downwash velocity, non-dimensionalized with respect to tip speed)positive down). Use only when location 92 = 1.	N.D.
1066-1085	---	Free	---
1086-1110	Δm_n	Cabled mass.	$lb\text{-}sec^2/in$

SIGN CONVENTIONS

a. Sign Convention for Rotor Hub Separation (Aft Rotor shown as First Rotor)

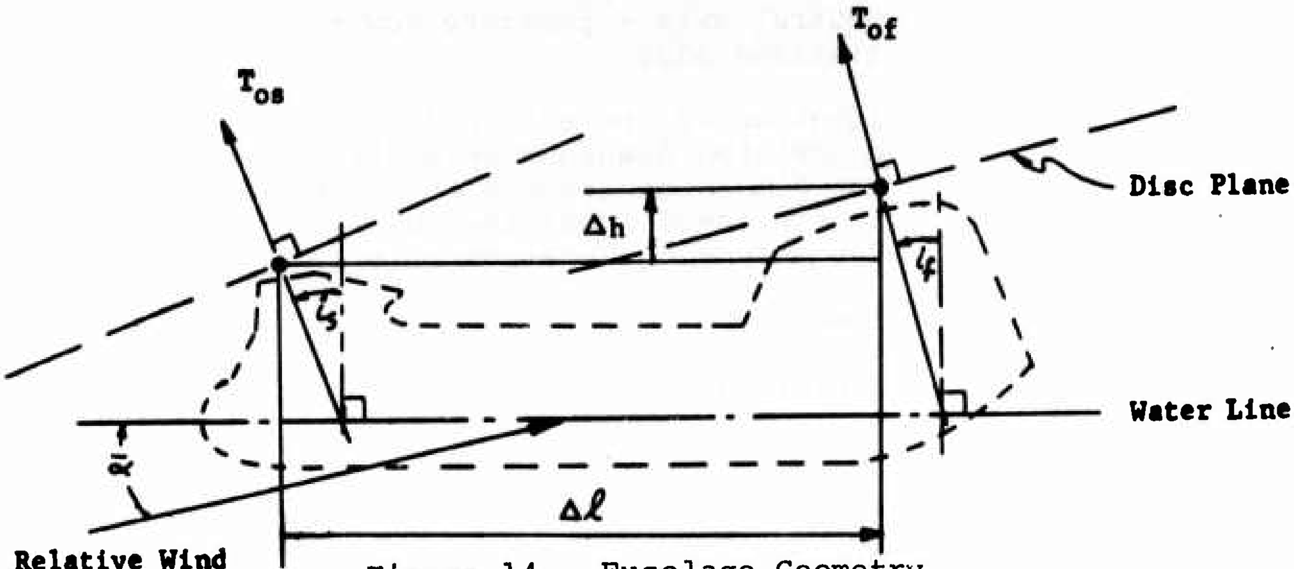


Figure 14. Fuselage Geometry

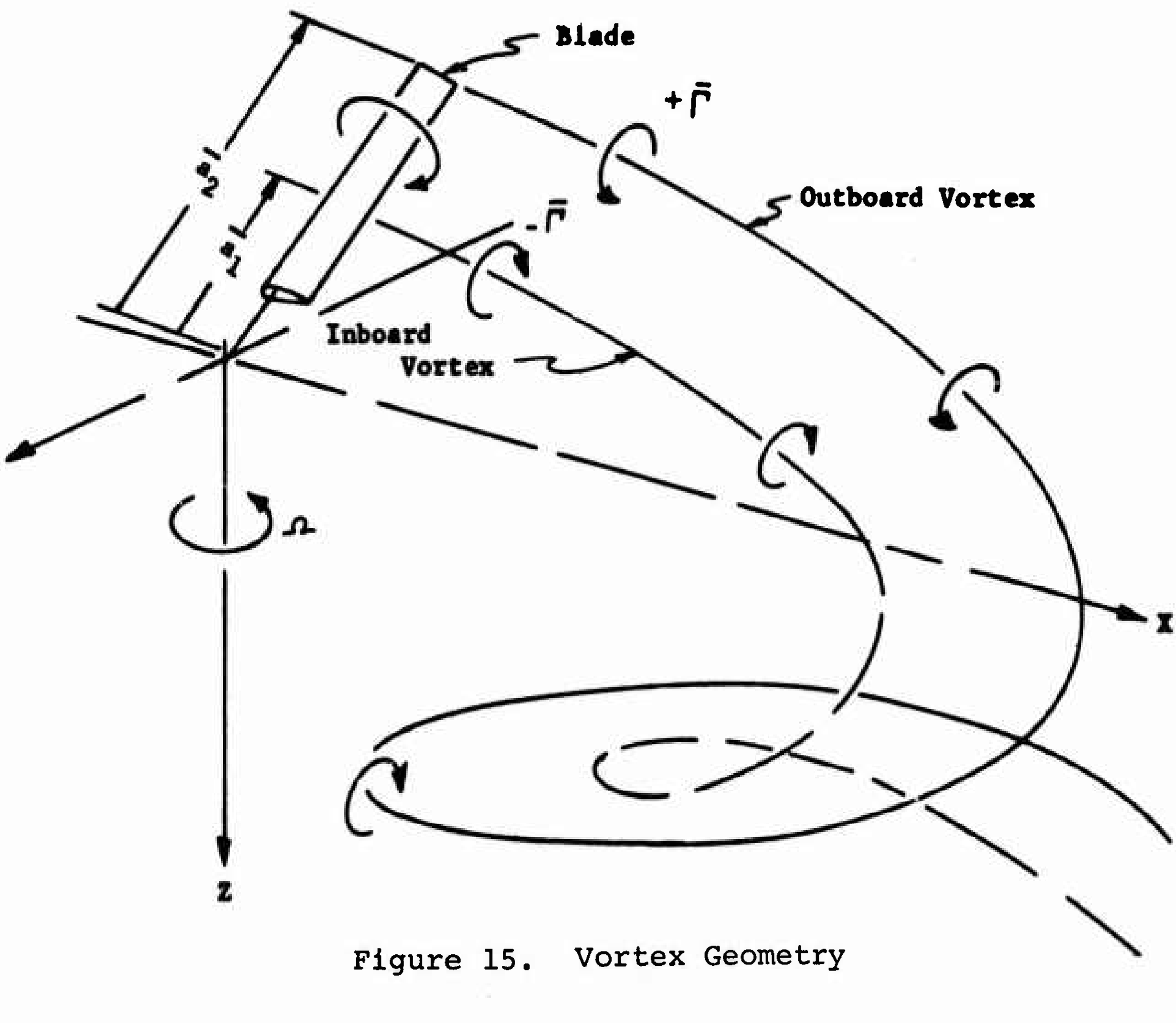


Figure 15. Vortex Geometry

b. <u>Airload Sign Convention</u>: Forces, deflections, and dimensions used in the airload calculations are shown in the positive direction at a blade station n.

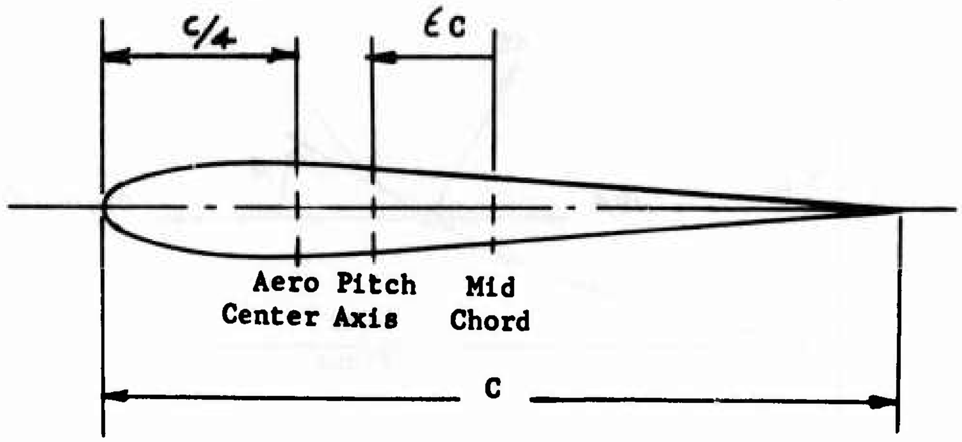


Figure 16. Blade Airfoil Geometry

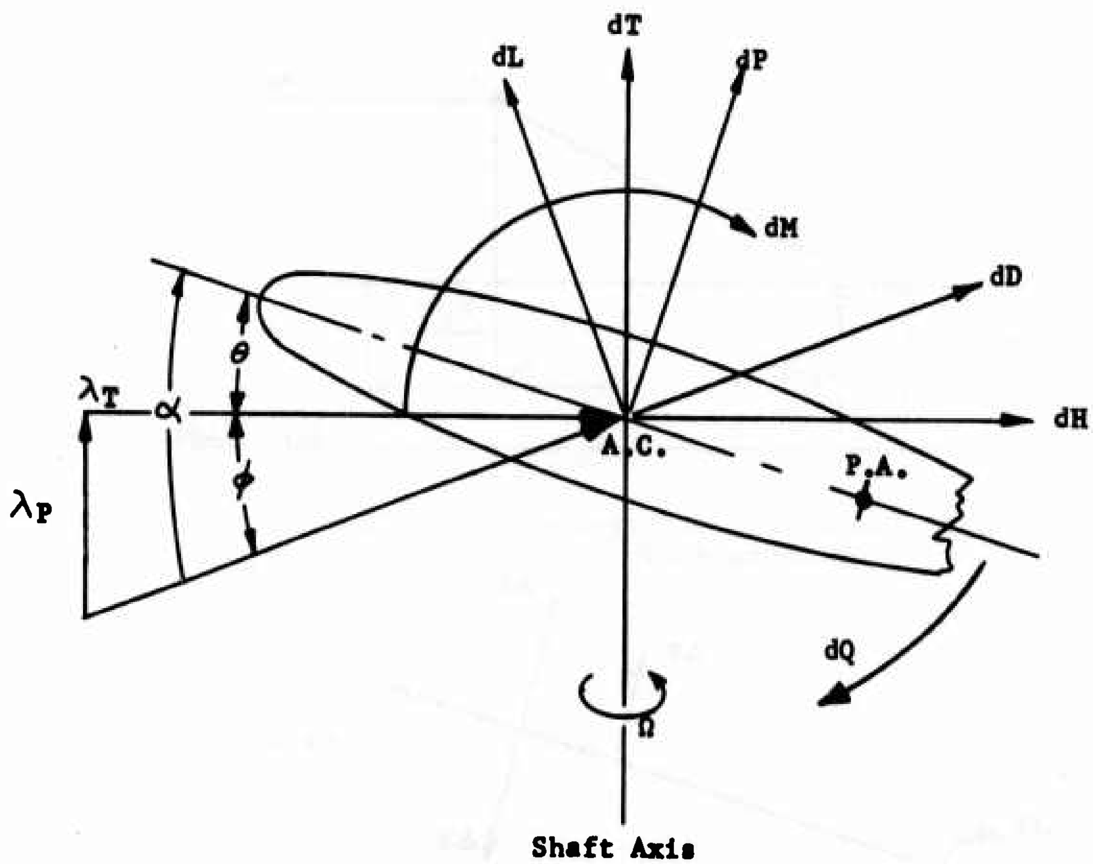


Figure 17. Airfoil Sign Convention

c. **Airload and Coriolis Sign Convention**

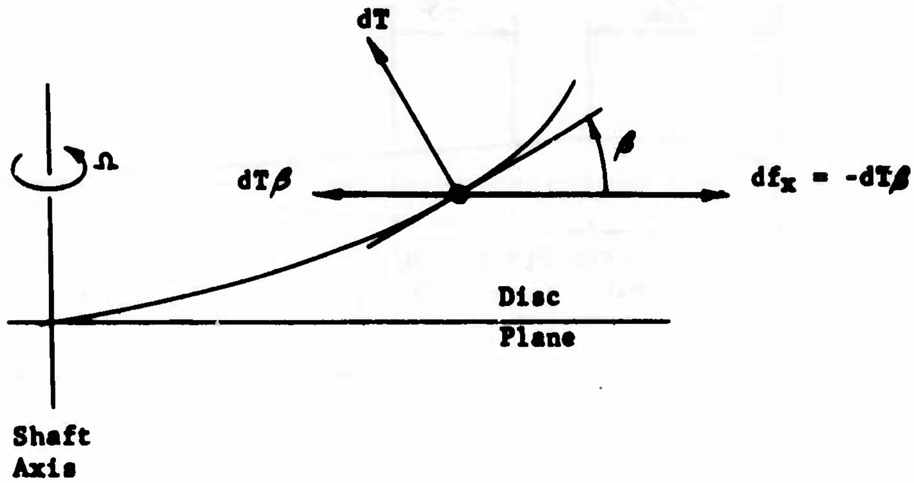


Figure 18. Radial Thrust Component Sign Convention

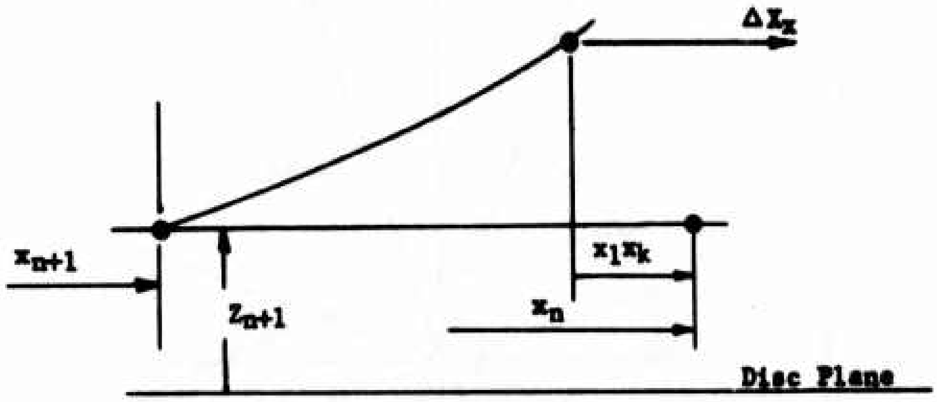


Figure 19. Radial Force Component From Flap Foreshortening Sign Convention

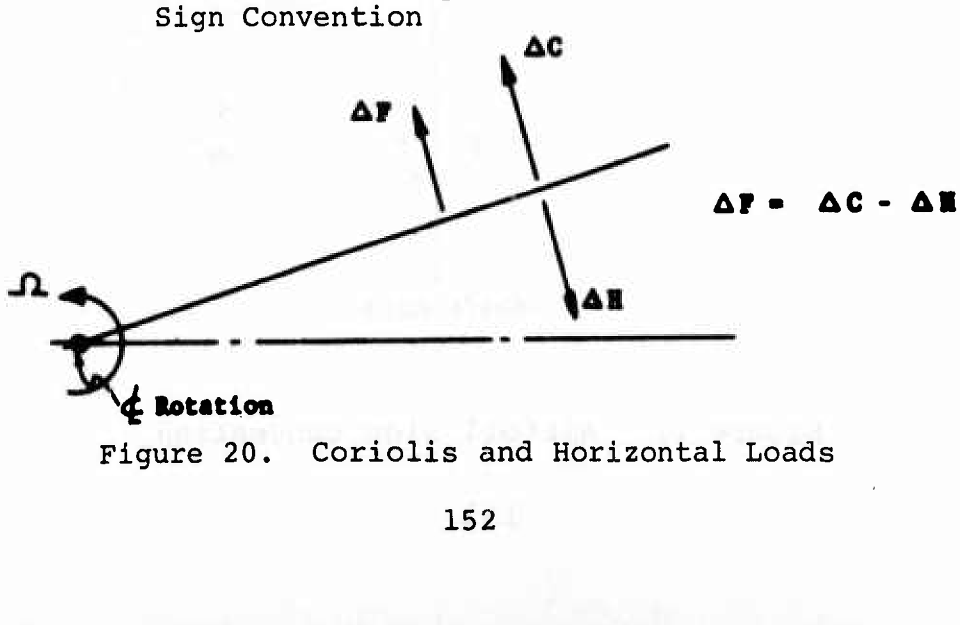


Figure 20. Coriolis and Horizontal Loads

d. <u>Response Conventions</u>: The sign conventions for the forces and displacements in coupled flap-pitch and uncoupled lag are shown below:

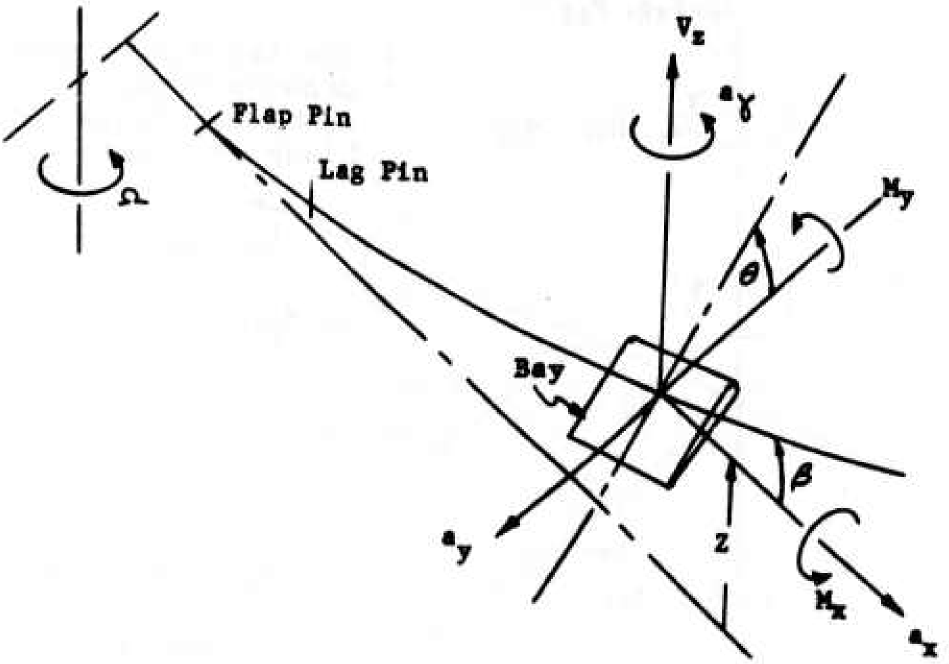
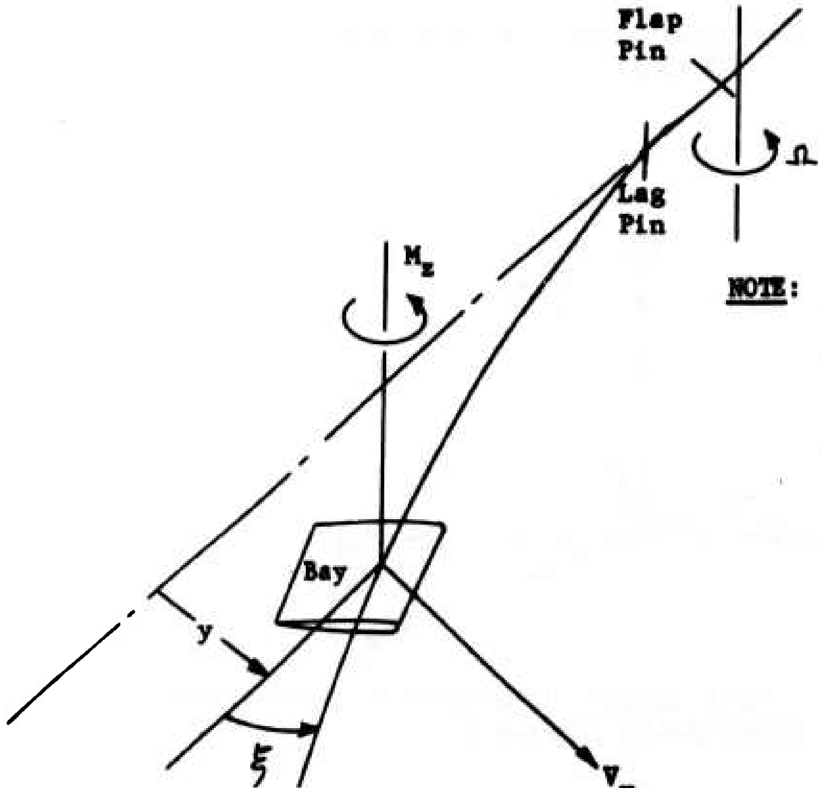


Figure 21. Coupled Flap-Pitch Sign Convention



<u>NOTE</u>: The convention applies to either rotor. Directions remaining consistent with the direction of rotation

Figure 22. Uncoupled Lag Sign Convention

e. <u>Hub Load Sign Convention</u>

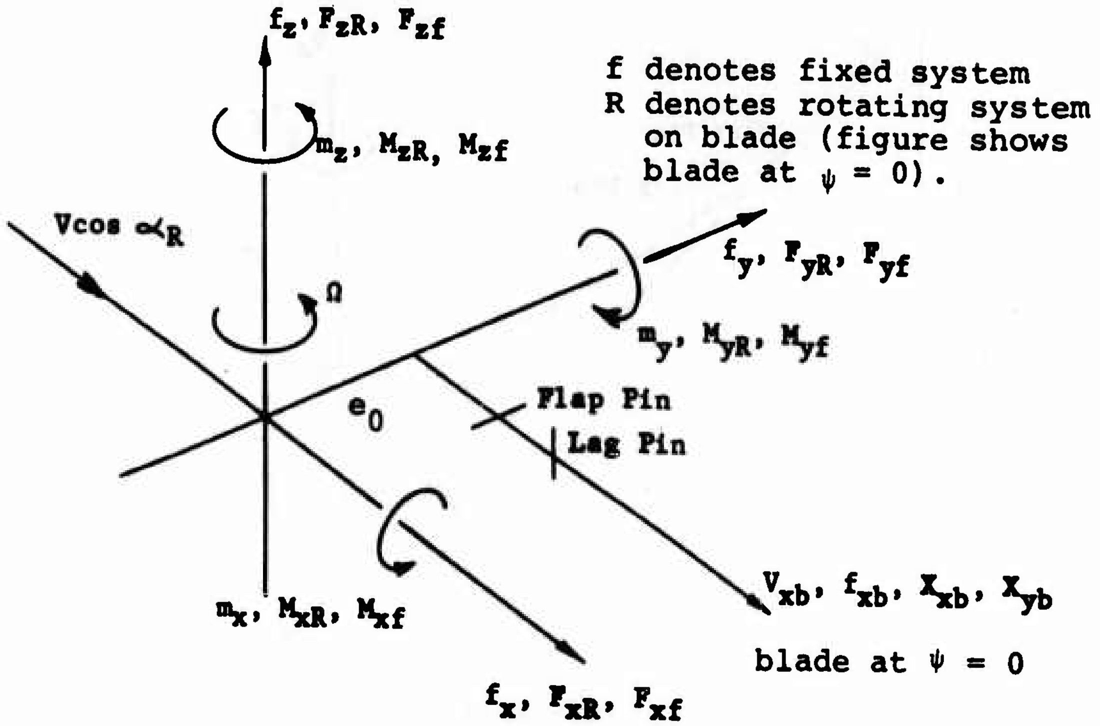


Figure 23. Rotating and Fixed-System Hub Loads Sign Convention (Shaft Axis System)

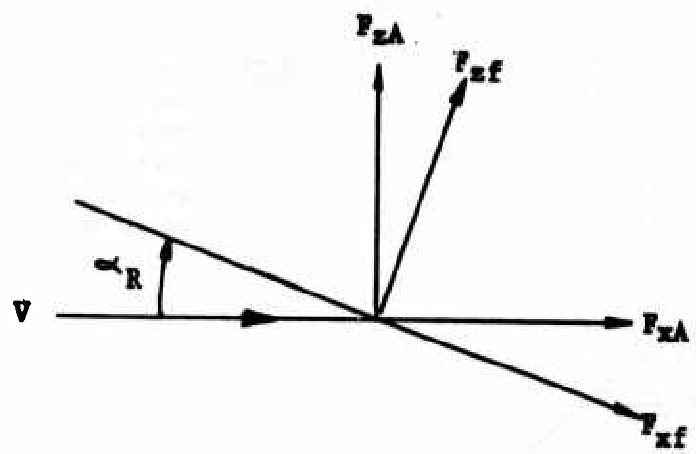


Figure 24. Steady Loads Relative to Airstream (Wind Axis System)

DESCRIPTION OF OUTPUT DATA

The program output is available in several versions depending on problem requirements. See locations 65 to 69. Described below is the output data in each of the program sections.

I Input Data - The input location number, n, and the value are printed out.

ANALYSIS SYMBOL	OUTPUT NAME	DESCRIPTION	DIMENSION
Loc n	Item n	Input location number n	--
--	Value	Value input in location n	See input description

II Initial Deflection - No printout.

III Downwash - The uniform downwash velocity normalized by the tipspeed for both rotors is printed. This is done for all downwash options.

If the program internally calculates nonuniform downwash (Location 92 = 0 or 3), then the following is printed:

1. Tip and root circulation strength normalized by rotor angular velocity versus blade station and azimuth position for one or both rotors, depending on location 93.

2. Downwash velocity normalized by tipspeed versus blade station and azimuth position for one or both rotors, depending on location 93.

3. Tip and root circulation strengths normalized by rotor angular velocity for the last downwash loop, before and after damping, versus azimuth position for one or both rotors, depending on location 93.

4. The total downwash velocity normalized by the tip-speed versus blade station and azimuth position for the rotor being analyzed.
   Total downwash = self-induced downwash
   + rotor interference downwash

5. A summary of the thrust routines used in the downwash calculations with complete details for thrust routine used in the zeroth and last downwash loops.

If nonuniform downwash is specified in locations 586 to 1065; i.e., location 92 = 1, then the following is printed:

1. Downwash velocity normalized by tipspeed versus blade station and azimuth for the rotor being analyzed.

Following the downwash routine output, the program prints the results of the airloads and coupled flap-pitch routines for each iteration. The specific airload parameters which are printed are controlled by the values in locations 65-67. Use of the thrust routine is controlled by locations 49 and 275.

IV <u>Airloads</u> - Complete output of the airloads routine includes:

1. Thrust routine.

2. Unsteady aerodynamics parameters at each blade station and azimuth position.

3. Airload perpendicular to the blade chord at each blade station and azimuth.

4. Vibratory aerodynamic pitching moment per unit length about the pitch axis.

5. Classical aerodynamic parameters (lift, drag, angles of attack, etc.) at each blade station and azimuth position.

6. Normal and radial components of thrust in harmonic form at each blade station.

7. Component of drag in the disc plane and the total aerodynamic pitching moment in harmonic form for each blade station.

8. Aerodynamic coefficients, C_L, C_D, C_M, as obtained from the double table look-up routine (after interpolation) at each blade station and azimuth.

<u>THRUST ROUTINE</u>

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
i	STA	Blade station number	---
ΔT_n	1st DEL T	Steady thrust along the rotor shaft at blade station n for the first value of collective used by the thrust routine. Positive up	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
ΔT_n	Last DEL T	Steady thrust along the rotor shaft at blade station n for the last value of collective used by the thrust routine. Positive up	lb
θ_4	THETA AT STA. 4	Blade mechanical angle of attack at station 4 Positive leading edge up	radians
T_O	THRUST	Total rotor thrust along rotor shaft Positive up	lb
	UNSTEADY AERODYNAMICS		
x	PSI	Blade azimuth - positive in direction of blade rotation	deg
F	F	Value of in-phase Theodorsen deficiency function	ND
G	G	Value of Theodorsen deficiency function phased 90° behind F	ND
α_{EQUIV}	ALPHA EQUIV	Dynamic angle of attack - angle of attack including Theodorsen deficiency functions F and G	radians
$\alpha_{REF\ L}$	ALPHA REF(L)	Quasi-static angle of attack adjusted for dynamic lift stall delay	radians
$\alpha_{REF\ M}$	ALPHA REF(M)	Quasi-static angle of attack adjusted for dynamic moment stall delay	radians
CL_{REF}	CL(REF)	Quasi-static lift coefficient based on $\alpha_{REF\ L}$	---
CL_{0-180}	CL(0-180)	Static lift coefficient at zero angle of attack, if in reverse-flow region angle of attack at 180°	---
$\bar{L}$	L BAR	Lift due to blade pitching velocity Positive up	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
$\dot{\alpha}_{BE}$	ALPHA DOT	Time derivative of $ALPHA_{BE}$ Positive leading edge up	$\frac{rad}{sec}$
$\dot{H}$	H DOT	Velocity of air normal to disc plane Positive up	$\frac{17}{sec}$

Note: If uniform downwash only is used; i.e., location 92 = 2, the downwash table versus blade station and azimuth is filed with the value of the uniform downwash.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
v_{o_f}	VZF	Uniform downwash velocity for forward rotor Positive down	ND WRT tipspeed
V_{o_s}	VZS	Uniform downwash velocity for aft rotor Positive down	ND WRT tipspeed
x	PSI	Blade azimuth position Positive in direction of rotation	deg
	LOOP	Number of lift-downwash compatibility iterations	---
Γ	GAMMA	Vortex circulation strength BEFORE refers to before damping AFTER refers to after damping Positive counterclockwise looking in direction of blade velocity	ND WRT blade angular velocity
i	STA	Blade station number	
v	VA	Downwash velocity Positive down	ND WRT tipspeed
θ_4	THETA	Blade mechanical angle of attack at station 4 Positive leading edge up	radians
T_o	THRUST	Total rotor thrust Positive up	lb
	NO ITER	Number of attempts required	---

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
ΔT_n	DELT	Steady thrust at blade station n along rotor shaft. FIRST DELT designates conditions for the first value of collective used by the thrust routine. LAST DELT designates conditions for last value of collection used by thrust rcutine. Positive up	lb
SL	L-B	One-half of the lift slope for the $\bar{L}$ term. $\frac{d}{d\alpha}$ CL	$\frac{1}{rad}$
cos	COS(YAW)	Cosine of yaw angle	---
$\bar{\phi}$	PHI	Dynamic induced blade angle of attack Positive leading edge up	
$\left.\frac{d\,C_L}{d\alpha}\right\|_{\alpha=0}$	REF SLOPE	Lift slope for α equal to zero	$\frac{1}{rad}$

AIRLOAD PERPENDICULAR TO CHORD

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
AL	---	Total airload perpendicular to blade chord Positive up	lb
r/R	RAD	Radial position of mass	ND WKT blade radians
AL_o	STDY	Steady value of total airload perpendicular to blade chord Positive up	
l	BAYL	Length of aerodynamic bay	in.
$\frac{AL-AL_o}{l}$	---	Vibratory airload perpendicular to blade chord per unit length Positive up	lb/in.
AMPL	AMPL	Amplitude of airload perpendicular to chord per unit length - equal to half peak-to-peak value	lb/in.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
$\frac{AL}{l}\ o$	STDY	Steady value of total airload perpendicular to chord line per unit length Positive up	lb/in.
Q	---	Vibratory aerodynamic pitching moment about the pitch axis per unit length Positive leading edge up	$\frac{\text{in.-lb}}{\text{in.}}$
AMPL	AMPL	Amplitude of the aerodynamic pitching moment about pitch axis per unit length	$\frac{\text{in.-lb}}{\text{in.}}$
Q_o/l	STDY	Steady value of aerodynamic pitching moment about the pitch axis per unit length Positive leading edge up	$\frac{\text{in.-lb}}{\text{in.}}$

CLASSICAL AERODYNAMICS

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
i_n	STATION	Blade station	---
r/R	x/R	Radial position for station n	ND to blade radius
x	PSI	Blade azimuth position Positive in direction of blade rotation	deg
θ	THETA	Blade mechanical angle of attack Positive leading edge up	rad
α	ALPHA	Blade total angle of attack Positive leading edge up	rad
ϕ	PHI	Induced blade angle of attack Positive leading edge up	rad
λ_p	LAMBP	Velocity component of the air normal to disc plane Positive up	ND to tipspeed
λ_t	LAMBT	Velocity component of the air in the disc plane Positive toward trailing edge	ND to tipspeed
MACH	MACH	Mach number based on U	---

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
U	U	Blade resultant velocity	ND to tipspeed
dfx	DFX	Bay radial force due to thrust Positive away from hub	lb
dT	T	Bay thrust along rotor shaft Positive up	lb
dH	H	Bay horizontal force Positive toward trailing edge	lb
dQ	Q	Total aerodynamic pitching moment about pitch axis Positive nose up	in.-lb
dL	L	Bay lift perpendicular to relative wind Positive up	lb
dD	D	Bay drag force parallel to relative wind Positive in direction of wind	lb
dM	M	Aerodynamic pitching moment about aerodynamic center Positive leading edge up	in.-lb

NORMAL AND RADIAL COMPONENTS OF THRUST IN HARMONIC FORM

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
K	K	Harmonic number	
fx_n	FXN	Total aerodynamic radial force at nth bay Positive away from hub	lb
dT	DEL T	Bay thrust perpendicular to disc plane Positive up	lb
dH	DEL H	Component of the aerodynamic force in the disc plane perpendicular to the pitch axis Positive toward trailing edge	lb
dQ	DEL Q	Aerodynamic pitching moment about the pitch axis Positive leading edge up	in.-lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
-	RESULTANT THRUST	Resultant (of harmonic analysis) of bay thrust	
-	RESULTANT DRAG	Resultant (of harmonic analysis) of component of aerodynamic force in disc plane perpendicular to pitch axis Positive toward trailing edge	lb
CL	CL	Dynamic lift coefficient obtained by multiplying dynamic lift slope, $\frac{d\ CL}{d\alpha}$ by α_{EQUIV}	ND
CD	CD	Coefficient of drag obtained from double table look-up including Mach number and $\alpha_{REF\ M}$	ND
CM	CM	Dynamic pitching moment coefficient obtained by using $\alpha_{REF\ M}$ and accounting for the shift in center of pressure due to stall	ND

V Aerodynamic Performance Parameters - Following the airloads certain aerodynamic performance parameters are printed out. Listed below are the aerodynamic parameters and their corresponding symbols.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
α_R	ALPHA R	Shaft angle relative to stream velocity	deg
V	VKNOTS	Freestream velocity	knots
$\frac{V}{R\Omega}$	V/R*OMEGA	Nondimensional freestream velocity	-
μ	MU	Advance ratio	-
α_{270}	ALPHA AT 270	Angle of attack at $\psi = 270°$	
T_O	TS	Rotor thrust perpendicular to disc plane	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
τ_s	TAU S	Steady torque	lb-ft
RHP	RHP	Rotor horsepower	hp
H	H	Drag in disc plane	lb
X	X	Propulsive force	lb
L	L	Lift force	lb
$\frac{X}{L}$	X/L	Ratio of propulsive force to lift force	-
$\frac{L}{D_e}$	L/DE	Lift force nondimensional to equivalent drag	-
$\frac{L}{qd^2\sigma}$	L/QD2SIG	Nondimensionalized lift	-
$\frac{X}{qd^2\sigma}$	X/QD2SIG	Nondimensionalized propulsive force	-
$\frac{P}{qd^2\sigma}$	P/QD2SIGV	Nondimensionalized rotor horsepower	
$\frac{C_J}{\sigma}$	CT/SIG	Nondimensionalized steady thrust	
$\frac{C_T}{\sigma}$	CTP/SIG	Nondimensionalized lift	
$\frac{C_H}{\sigma}$	CH/SIG	Nondimensionalized drag	
$\frac{C_P}{\sigma}$	CP/SIG	Nondimensionalized rotor horsepower	
Δx	X	Radial foreshortening due to flap and lag motion Positive toward tip In i-x form for aerodynamic stations	in.
ΔC	C	Coriolis inertia force Positive toward leading edge	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
Δx	XK	Radial foreshortening due to flap and lag motion Positive toward tip In harmonic form for aerodynamic stations only	in.

VI After the airloads, the program performs the response calculations. The coupled flap-lag-pitch routine results include blade linear and angular deflections in both the undeflected blade and disc plane coordinate systems. It also produces the blade shears and moments in both the undeflected blade and blade coordinate systems.

<u>COUPLED FLAP-PITCH RESPONSE</u> in harmonic form in undeflected blade coordinate system (cosine coefficients on top)

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
V_Z	VZ	Vertical shear in Z direction in undeflected blade coordinate system Positive up	lb
M_Y	MY	Flap bending moment about Y axis in undeflected blade coordinate system Positive blade tip up	in.-lb
β	BETA	Blade flap angle in undeflected blade coordinate system Positive blade tip up	radians
Z	Z	Blade flap deflection in undeflected blade coordinate system Positive up	in.
M_X	MX	Torsional moment about X axis in undeflected blade coordinate system Positive leading edge up	in.-lb
θ	THETA	Blade pitch angle in undeflected blade coordinate system Positive leading edge up	radians

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
V_Y	VY	Chordwise shear in Y direction in undeflected blade coordinate system Positive toward leading edge	lb
M_Z	MZ	Lag bending moment about Z axis in undeflected blade coordinate system Positive trailing edge in tension	lb
ζ	ZETA	Blade lag angle in undeflected blade coordinate system Positive blade leading	radians
Y	Y	Blade lag deflection in undeflected blade coordinate system Positive toward leading edge	in.

Note: For a blade which is articulated in lag, the lag boundary is at the lag hinge and so one less mass station is considered.

COUPLED FLAP-LAG-PITCH RESPONSE as a function of blade station and azimuth in the undeflected blade coordinate system including amplitudes and steadies. The transformation from harmonic to time history form is done in the last iteration only.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
V_Z	VZ	Vibratory vertical shear in Z direction in undeflected blade coordinate system Positive up	lb
M_Y	MY	Vibratory flap bending moment about Y axis in undeflected blade coordinate system Positive blade tip up	in.-lb
β	BETA	Vibratory flap angle in undeflected blade coordinate system Positive tip up	radians

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
Z	Z	Vibratory flap deflection in undeflected blade coordinate system Positive tip up	in.
M_X	MX	Vibratory torsional moment about X axis in undeflected blade coordinate system Positive leading edge up	in.-lb
θ	THETA	Vibratory pitch angle in undeflected blade coordinate system Positive leading edge up	radians
V_Y	VY	Vibratory chordwise shear in Y direction in undeflected blade coordinate system Positive toward leading edge	lb
M_Z	MZ	Vibratory lag bending moment about Z axis in undeflected blade coordinate system Positive trailing edge in tension	in.-lb
ζ	ZETA	Vibratory lag angle in undeflected blade coordinate system Positive blade leading	radians
Y	Y	Vibratory lag deflection in the undeflected blade coordinate system Positive toward trailing edge	in.
V_X	VX	Vibratory radial shear in X direction in undeflected blade coordinate system Positive away from hub	lb
$\Delta\theta$	DELTA THETA	Incremental torsional deflection due to bending of the torsional axis in undeflected blade coordinate system Positive leading edge up	rad

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
ΔY	DELTA Y	Incremental lag deflection due to bending of the torsional axis in undeflected blade coordinate system Positive toward trailing edge	in.
ΔZ	DELTA Z	Incremental flap deflection due to bending of the torsional axis in undeflected blade coordinate system Positive up	in.

<u>COUPLED FLAP-LAG-PITCH RESPONSE</u> as a function of blade station and azimuth in the blade coordinate system including amplitudes and steadies. Only stations outboard of the lag hinge are considered. These results are calculated in the last iteration only.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
V_{xr}	VXB	Vibratory radial shear in X direction in blade coordinate system Positive away from hub	lb
V_{yr}	VYB	Vibratory chordwise shear in Y direction in blade coordinate system Positive toward leading edge	lb
V_{zr}	VZB	Vibratory vertical shear in Z direction in blade coordinate system Positive up	lb
M_{xr}	MXB	Vibratory torsional moment about X axis in blade coordinate system Positive leading edge up	in.-lb
M_{yr}	MYB	Vibratory flap bending moment about Y axis in blade coordinate system Positive leading edge up	in.-lb
M_{zr}	MZB	Vibratory lag bending moment about Z axis in blade coordinate system Positive trailing edge in tension	in.-lb

COUPLED FLAP-LAG-PITCH linear and angular deflections, velocities, and accelerations in disc plane coordinate system as a function of blade station and azimuth.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
Y	Y	Lag deflection in disc plane coordinate system Positive toward trailing edge	in.
Z	Z	Flap deflection in disc plane coordinate system Positive up	in.
θ	THETA	Torsional angular deflection in disc plane coordinate system Positive leading edge up	rad
β	BETA	Flap angular deflection in disc plane coordinate system Positive tip up	rad
ζ	ZETA	Lag angular deflection in disc plane coordinate system Positive blade leading	rad

VII After the response for the last iteration is printed the program calculates the hub and control loads. The calculated quantities include hub loads due to one blade expressed in the rotating disc plane coordinate systems and the total hub loads due to all blades expressed in both the fixed and rotating disc plane coordinate systems. Also calculated are the pitch link and actuator loads.

HUB LOADS FOR ONE BLADE ONLY

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
k	K	Harmonic number	
X_{xb}	X XB	Root radial force due to flap foreshortening in rotating disc plane coordinate system Positive away from hub	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
X_{yb}	X YB	Root radial force due to coriolis acceleration in rotating disc plane coordinate system Positive away from hub	lb
f_{xb}	F XB	Root radial force due to thrust in rotating disc plane coordinate system Positive away from hub	lb
V_{xb}	V XB	Total root radial force (XXB + XYB + FXB) in rotating disc plane coordinate system (steady value also contains a_x) Positive away from hub	lb
F_x	FX	Radial hub load for one blade in rotating disc plane coordinate system Positive away from hub	lb
F_y	FY	Tangential hub load for one blade in rotating disc plane coordinate system Positive toward leading edge	lb
F_z	FZ	Axial hub load for one blade in rotating disc plane coordinate system, in direction of rotor shaft axis Positive in the direction of positive thrust	lb
M_x	MX	Pitching moment at center of rotation for one blade in rotating disc plane coordinate system Positive leading edge up	in.-lb
M_y	MY	Flapping moment of center of rotation for one blade in rotating disc plane coordinate system Positive blade tip up	in.-lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
M_z	MZ	Torque at center of rotation for one blade in rotating disc plane coordinate system (same as fixed disc plane system torque) Positive trailing edge in torsion	in.-lb

TOTAL ROTATING HUB LOADS AT ROTOR CENTER FOR ALL BLADES

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
F_{xr}	FXR	X component of load transmitted to hub by all blades in rotating disc plane coordinate system (X axis rotates with blade being analyzed) Positive away from hub	lb
F_{yr}	FYR	Y component of load transmitted to hub by all blades in rotating disc plane coordinate system Positive toward leading edge	lb
F_{zr}	FZR	Axial component of load transmitted to hub by all blades in rotating disc plane coordinate system Positive in direction of positive thrust	lb
M_{xr}	MXR	Moment about X axis transmitted to hub by all blades in rotating disc plane coordinate system (X axis rotates with blade being analyzed) Positive leading edge up	in.-lb
M_{yr}	MYR	Moment about Y axis transmitted to hub by all blades in rotating disc plane coordinate system Positive blade tip up	in.-lb
M_{zr}	MZR	Torque at center of rotation due to all blades in rotating disc plane coordinate system (same as fixed disc plane system) Positive trailing edge in tension	in.-lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
F_{xf}	FXF	X component of load transmitted to hub by all blades in fixed disc plane coordinate system Positive in direction zero degree azimuth position	lb
F_{yf}	FYF	Y component of load transmitted to hub by all blades in fixed disc plane coordinate system Positive in direction of 90-degree azimuth position	lb
F_{zf}	FZF	Axial component of load transmitted to hub by all blades in fixed disc plane coordinate system Positive in direction of positive thrust	lb
M_{xf}	MXF	Moment due to all blades about Y axis in fixed disc plane coordinate system Positive using right-hand rule	in.-lb
M_{yf}	MYF	Moment due to all blades about Y axis in fixed disc plane coordinate system Positive using right-hand rule	in.-lb
M_{zf}	MZF	Torque at center of rotation due to all blades about Z axis in fixed disc plane system Positive using right-hand rule	in.-lb
F_x	FXF A	Steady force in X direction of wind axis coordinate system (X axis is downwind) Positive in direction of positive X	lb
F_y	FYF A	Steady force in Y direction of wind axis coordinate system (same as force in Y direction of fixed disc plane coordinate system) Positive in direction of positive Y	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
F_z	FZF A	Steady force in Z direction of wind axis coordinate system Positive in direction of positive Z	lb
M_x	MXF A	Steady moment about X axis in wind axis coordinate system Positive using right-hand rule	in.-lb
M_y	MYF A	Steady moment about Y axis in wind axis coordinate system (same as moment about Y axis in fixed disc plane coordinate system) Positive using right-hand rule	in.-lb
M_z	MZF A	Steady moment about Z axis in wind axis coordinate system Positive using right-hand rule	in.-lb
RHP	RHP	Rotor horsepower	

PITCH LINK AND ACTUATOR LOADS

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
k	K	Harmonic number C denotes cosine coefficient S denotes sine coefficient Plane number denotes resultant	
P	FLB	Harmonic coefficients of pitch link load Positive in compression	lb
P_1	P1 LB	Load in first actuator in harmonic form Positive in compression	lb
P_2	P2 LB	Load in second actuator in harmonic form Positive in compression	lb
P_3	P3 LB	Load in third actuator in harmonic form Positive in compression	lb

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
ψ	PSI	Blade azimuth position	deg
P	F	Vibratory pitch link load in time history form Positive in compression	lb
P_1	P1	Vibratory load in first actuator in time history form Positive in compression	lb
P_2	P2	Vibratory load in second actuator in time history form Positive in compression	lb
P_3	P3	Vibratory load in third actuator in time history form Positive in compression	lb

Note: Maximum positive, maximum negative, and the amplitude (= 1/2 MAX POS - MAX NEG) are also indicated for the time histories of the vibratory pitch link and actuator loads.

PERFORMANCE PARAMETERS BASED ON HUB LOADS

Following the hub loads calculation, the program reevaluates some of the performance parameters in terms of the hub loads.

VIII PITCH LINK LOAD SUMMARY PAGE

For all output options a summary of the pitch link loads is provided. The vibratory pitch link loads are printed in time history form in 15-degree azimuth increments for all iterations. The corresponding amplitudes and steady values are given. In addition, the last iteration vibratory pitch link loads in time history form are given in 5-degree azimuth increments.

IX CONVERGENCE SUMMARY PAGE

For all output options a summary of the program convergence is given on the last page of the output. The quantities described are given in the table below and are listed for each iteration.

ANALYSIS SYMBOL	OUTPUT SYMBOL	DESCRIPTION	DIMENSION
θ_4	COLLECTIVE	Blade mechanical angle of attack at station 4	deg
x/R	X/R	Radial position at which θ_4 is specified	ND with respect to radius
To	THRUST	Total rotor thrust	lb
α_4 0	PSI = 0	Blade angle of attack at station 4 and 0-degree azimuth position Positive leading edge up	deg
α_4 90	PSI = 90	Blade angle of attack at station 4 and 90-degree azimuth position Positive leading edge up	deg
α_4 180	PSI = 180	Blade angle of attack at station 4 and 180-degree azimuth position Positive leading edge up	deg
α_4 270	PSI = 270	Blade angle of attack at station 4 and 270-degree aximuth position Positive leading edge up	deg
Z	Z TIP AMPL	Blade tip flapping deflection amplitude Always positive	in.
θ	THETA TIP AMPL	Blade tip torsional deflection amplitude Always positive	deg
M_Y	ROOT FBM AMPL	Root flap bending moment amplitude Always positive	in.-lb

SAMPLE PROGRAM INPUT AND OUTPUT

ROTOR ANALYSIS PROGRAM C-70

TITLE BO-105 TEST CASE

AIRFOIL TABLES

	C_L	C_D	C_M
1	269	269	502
2			
3			
4			
5			

DEF.	LOC.	VALUE	DIM.
V	1	100.	KTS.
α	2	-10.	DEG.
Ω	3	425.	R.P.M.
ρ	4	0.002378	SL/FT³
S	5	117.	FT/SEC
Forward Rotor			
T_O	7	4400.	LBS.
θ_O	8	12.3	DEG.
θ_{1C}	9	0.	DEG.
θ_{1S}	10	0.	DEG.
β_O	11	2.5	DEG.
β_{1C}	12	0.	DEG.
β_{1S}	13	0.	DEG.
Aft Rotor			
T_O	15		LBS.
θ_O	16		DEG.
θ_{1C}	17		DEG.
θ_{1S}	18		DEG.
β_O	19		DEG.
β_{1C}	20		DEG.
β_{1S}	21		DEG.
θ DEG.	22		2C
	23		2S
	24		3C
	25		3S
	26		4C
	27		4S
	28		5C
	29		5S
	30		6C
	31		6S
	32		7C
	33		7S
	34		8C
	35		8S
	36		9C
	37		9S
	38		10C
	39		10S
CONTROLS	40		Γ_A OPT.
	41		C_M OPT.
	42		Γ OPT.
	43	0.	SPRING MATRIX
	44		
	45		

DEF.	LOC.	VALUE	DIM.
CONTROLS	46	1.	ROTOR
	47	4.	No. of blades
	48	10.	No. of iterations
	49	1.	Thrust Routine
	50	0.	Linear Aero
a_∞	51	5.73	∞/RAD.
T.L.	52		N.D.
Δ_L	53		RAD.
Δ_M	54		RAD.
A	55		
FGC	56		
F	57		N.D.
G	58		N.D.
k	59		
A.T.	60		DEG.
Γ	61		
g	62	32.2	FT/SEC²
V_{OF}	63		FT/SEC²
V_{OF}	64		FT/SEC²
CONTROLS	65	1.	Iteration Output
	66	1.	Force Output
	67	1.	Flap Output
	68	1.	Lag Output
	69	1.	Hub Load Output
	70	0.	Hub Motion
ΔC_M N.D.	71		n=1
	72		n=2
	73		n=3
	74		n=4
	75		n=5
	76		n=6
	77		n=7
	78		n=8
	79		n=9
	80		n=10
	81		n=11
	82		n=12
	83		n=13
	84		n=14
	85		n=15
	86		n=16
	87		n=17
	88		n=18
	89		n=19
	90		n=20

DEF.	LOC.	VALUE	DIM.
DOWNWASH CONTROLS	91	1.	V_O Calculation
	92	2.	NUD-UD ODT
	93	1.	N.U.D. TYPE
	94	1.	Vortex TYPE
	95		Near Wake Iter
	96		F.W. Iter-SI
	97		F.W. Iter-RI
	98		Vortex Spiral
	99		Inboard Vortex
	100		Outboard Vortex
	101		V_t opt
	102		$\bar{a}$
	103		
	104		
	105		
	106		
	107		
	108		
	109		
	110		
	111		
	112		
	113		
	114		
	115		
β DEG.	116		2C
	117		2S
	118		3C
	119		3S
	120		4C
	121		4S
	122		5C
	123		5S
	124		6C
	125		6S
	126		7C
	127		7S
	128		8C
	129		8S
	130		9C
	131		9S
	132		10C
	133		10S
B	134		N.D
	135		

DEF.	LOC.	VALUE	DIM.
	136		
	137		
	138		
	139		
	140		
	141		
	142		
	143		
	144		
$\gamma_L^{(1)}$	145	1.5	M = 0
	146	1.5	.2
	147	1.0	.4
	148		.6
	149		.8
	150		1.
$\gamma_M^{(1)}$	151	1.0	M = 0
	152	1.0	.2
	153	0.75	.4
	154		.6
	155		.8
	156		1.
$\gamma_L^{(2)}$	157		M = 0
	158		.2
	159		.4
	160		.6
	161		.8
	162		1.
$\gamma_M^{(2)}$	163		M = 0
	164		.2
	165		.4
	166		.6
	167		.8
	168		1.
$\gamma_L^{(3)}$	169		M = 0
	170		.2
	171		.4
	172		.6
	173		.8
	174		1.
$\gamma_M^{(3)}$	175		M = 0
	176		.2
	177		.4
	178		.6
	179		.8
	180		1.

DEF.	LOC.	VALUE	DIM.
	181		
	182		
	183		
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	210		
TORS. DAMPING COEF.	211		C_{Z1}
	212		C_{Z2}
	213		C_{Z3}
	214		C_{Z4}
	215		C_{Z5}
	216		C_{Z6}
	217		C_{Z7}
	218		C_{Z8}
	219		C_{Z9}
	220		C_{Z10}
$r\,R_1$	221		
$r\,R_2$	222		
$r\,R_3$	223		
$r\,R_4$	224		
$r\,R_5$	225		

DEF.	LOC.	VALUE	DIM.
	226		
	227		
	228		
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	230		
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	257		
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	263		
	264		
	265		
CD_1	266		
CD_2	267		
CD_3	268		
	269		
	270		

FORM 52171 (7/71)

ROTOR ANALYSIS PROGRAM C-70

TITLE: BO-105

BLADE TITLE:

DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE
R	271	16.11	FT.		316	1.		361	0.4
C_o	272	10.93	IN.		317	1.		362	0.6
NO. AERO	273	10.			318	1.		363	0.8
NO. MASS	274	15.			319	1.		364	0.8
FLAP BDRY	275	4.			320	1.		365	0.8
LAG BDRY	276	2.			321	1.		366	0.8
e_o	277	0.	IN.		322	1.		367	0.8
b	278	6.45	IN.		323	1.		368	0.6
δ_3	279	0.	DEG.		324	1.		369	0.38
i_{FWD}	280	3.	DEG.	$\frac{C_n}{C_o}$	325	1.	$\Delta\theta_t$	370	-4.12
i_{AFT}	281		DEG.		326		DEG.	371	
$\Delta\ell/_R$	282		N.D.		327			372	
$\Delta h/_R$	283		N.D.	N.D.	328			373	
K_β	284		LB-IN./RAD.		329			374	
C_β	285		LB-IN-SEC/RAD.		330			375	
K_ζ	286		LB-IN./RAD.		331			376	
C_ζ	287		LB-IN-SEC/RAD.		332			377	
q_B	288		N.D.		333			378	
q_T	289		N.D.		334			379	
	290	1.0	i = 1		335			380	
	291	0.95	i = 2		336	.01126		381	0.
	292	0.9	i = 3		337	.00773		382	0.
	293	0.8	i = 4		338	.01546		383	0.
	294	0.7	i = 5		339	.01494		384	0.
	295	0.6	i = 6		340	.01491		385	0.
	296	0.5	i = 7		341	.01491		386	0.
	297	0.4	i = 8		342	.01491		387	0.
	298	0.3	i = 9		343	.01491		388	0.
	299	0.25	i = 10		344	.00746		389	0.
	300	0.22	i = 11		345	.00447		390	0.
$\frac{X_1}{R}$	301	0.16	i = 12	m_n	346	.00900	Y_{on}	391	0.
	302	0.1	i = 13		347	.01129		392	0.
N.D.	303	0.05	i = 14	LBS-SEC²/IN.	348	.07913	IN	393	0.
	304	0.001	i = 15		349	.07694		394	0.
	305	0.	i = 16		350	.00115		395	0.
	306		i = 17		351			396	
	307		i = 18		352			397	
	308		i = 19		353			398	
	309		i = 20		354			399	
	310		i = 21		355			400	
	311		i = 22		356			401	
	312		i = 23		357			402	
	313		i = 24		358			403	
	314		i = 25		359			404	
	315		i = 26		360			405	

DEF.	LOC.	VALUE	DEF.	LOC.	VALUE	DIM.	DEF.	LOC.	VALUE	DEF.	LOC.	VALUE
	406	0.25		451	1.36 E6			496	2.38 E6		541	59.4 E6
	407	0.25		452	1.36 E6			497	2.38 E6		542	59.4 E6
	408	0.25		453	1.36 E6			498	2.38 E6		543	59.4 E6
	409	0.25		454	1.36 E6			499	2.38 E6		544	59.4 E6
	410	0.25		455	1.36 E6			500	2.38 E6		545	59.4 E6
	411	0.25		456	1.36 E6			501	2.38 E6		546	59.4 E6
	412	0.25		457	1.36 E6			502	2.38 E6		547	59.4 E6
	413	0.25		458	1.36 E6			503	2.38 E6		548	59.4 E6
	414	0.25		459	1.4076 E6			504	2.38 E6		549	59.4 E6
ϵ_n	415	0.25		460	1.6742 E6			505	2.3953 E6		550	49.102 E6
N.D.	416		GJ_N	461	2.719 E6		EI_F	506	2.9209 E6	EI_ζ	551	29.486 E6
	417			462	4.0285 E6			507	5.9924 E6		552	33.909 E6
	418		LB-IN²	463	4.1 E6		LB-IN²	508	230.76 E6	LB-IN²	553	260. E6
	419			464	4.1 E6			509	331.63 E6		554	335.23 E6
	420			465	4.1 E6			510	850.0 E6		555	335.23 E6
	421			466				511			556	
	422			467				512			557	
	423			468				513			558	
	424			469				514			559	
	425			470				515			560	
	426	.04839		471				516			561	
	427	.04839		472				517			562	
	428	.09678		473				518			563	
	429	.09678		474				519			564	
	430	.09678		475				520			565	
	431	.09678	R_L	476	9.	IN.		521			566	
	432	.09678	Y_L	477	0.	DEG.		522			567	
	433	.09678	R_1	478	5.	IN.		523			568	
	434	.04839	R_2	479	5.	IN.		524			569	
	435	.02903	R_3	480	5.	IN.		525			570	
I_θ	436	.04992	R_4	481	0.	IN.		526			571	
	437	.02986	Y_1	482	10.	DEG.		527			572	
	438	.99162	Y_2	483	130.	DEG.		528			573	
	439	.02083	δ_3	484	250.	DEG.		529			574	
LBS-SEC²-IN.	440	.00043	Y_4	485	0.	DEG.		530			575	
	441		a	486		DEG.		531			576	
	442		b	487		DEG.		532			577	
	443		c	488		DEG.		533			578	
	444		d	489		DEG.		534			579	
	445		k_z	490	1680.	LB/IN.		535			580	
	446			491				536			581	
	447			492				537			582	
	448			493				538			583	
	449			494				539			584	
	450			495				540			585	

FORM 52172 (7/71)

MODIFIED AIRFOIL TABLES

269 269 V23010-1.58 STALLABLE CL-IOM 8-7441-1-363,CD-TABLE 502 E.AU

PRINT OUT OF INPUT VALUES

ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,
1	1.0000E 02	2	-1.0000E 01	3	4.2500E 02	4	2.3780E-03	5	1.1170E 03	6	0.0	7	4.4000E 03
8	8.5000E 00	9	0.0	10	0.0	11	2.5000E 00	12	0.0	13	0.0	14	0.0
15	0.0	16	0.0	17	0.0	18	0.0	19	0.0	20	0.0	21	0.0
22	0.0	23	0.0	24	0.0	25	0.0	26	0.0	27	0.0	28	0.0
29	0.0	30	0.0	31	0.0	32	0.0	33	0.0	34	0.0	35	0.0
36	0.0	37	0.0	38	0.0	39	0.0	40	0.0	41	0.0	42	0.0
43	0.0	44	0.0	45	0.0	46	1.0000E 00	47	4.0000E 00	48	1.0000E 01	49	1.0000E 00
50	0.0	51	5.7300E 00	52	0.0	53	0.0	54	0.0	55	0.0	56	0.0
57	0.0	58	0.0	59	0.0	60	0.0	61	0.0	62	3.2200E 01	63	0.0
64	0.0	65	1.0000E 00	66	1.0000E 00	67	1.0000E 00	68	1.0000E 00	69	1.0000E 00	70	0.0
71	0.0	72	0.0	73	0.0	74	0.0	75	0.0	76	0.0	77	0.0
78	0.0	79	0.0	80	0.0	81	0.0	82	0.0	83	0.0	84	0.0
85	0.0	86	0.0	87	0.0	88	0.0	89	0.0	90	0.0	91	1.0000E 00
92	2.0000E 00	93	1.0000E 00	94	1.0000E 00	95	0.0	96	0.0	97	0.0	98	0.0
99	0.0	100	0.0	101	0.0	102	0.0	103	0.0	104	0.0	105	0.0
106	0.0	107	0.0	108	0.0	109	0.0	110	0.0	111	0.0	112	0.0
113	0.0	114	0.0	115	0.0	116	0.0	117	0.0	118	0.0	119	0.0
120	0.0	121	0.0	122	0.0	123	0.0	124	0.0	125	0.0	126	0.0
127	0.0	128	0.0	129	0.0	130	0.0	131	0.0	132	0.0	133	0.0
134	0.0	135	0.0	136	0.0	137	0.0	138	0.0	139	0.0	140	0.0
141	2.5000E-01	142	1.0000E 00	143	0.0	144	0.0	145	1.5000E 00	146	1.5000E 00	147	1.0000E 00
148	0.0	149	0.0	150	0.0	151	1.0000E 00	152	1.0000E 00	153	7.5000E-01	154	0.0
155	0.0	156	0.0	157	0.0	158	0.0	159	0.0	160	0.0	161	0.0
162	0.0	163	0.0	164	0.0	165	0.0	166	0.0	167	0.0	168	0.0
169	0.0	170	0.0	171	0.0	172	0.0	173	0.0	174	0.0	175	0.0
176	0.0	177	0.0	178	0.0	179	0.0	180	0.0	181	0.0	182	0.0
183	0.0	184	0.0	185	0.0	186	0.0	187	0.0	188	0.0	189	0.0
190	0.0	191	0.0	192	0.0	193	0.0	194	0.0	195	0.0	196	0.0
197	0.0	198	0.0	199	0.0	200	0.0	201	0.0	202	0.0	203	0.0
204	0.0	205	0.0	206	0.0	207	0.0	208	0.0	209	0.0	210	0.0
211	0.0	212	0.0	213	0.0	214	0.0	215	0.0	216	0.0	217	0.0
218	0.0	219	0.0	220	0.0	221	0.0	222	0.0	223	0.0	224	0.0
225	0.0	226	0.0	227	0.0	228	0.0	229	0.0	230	0.0	231	0.0
232	0.0	233	0.0	234	0.0	235	0.0	236	0.0	237	0.0	238	0.0
239	0.0	240	0.0	241	0.0	242	0.0	243	0.0	244	0.0	245	0.0
246	0.0	247	0.0	248	0.0	249	0.0	250	0.0	251	0.0	252	0.0
253	0.0	254	0.0	255	0.0	256	0.0	257	0.0	258	0.0	259	0.0
260	0.0	261	0.0	262	0.0	263	0.0	264	0.0	265	0.0	266	0.0
267	0.0	268	0	269	0.0	270	0.0	271	1.6110E 01	272	1.0930E 01	273	1.0000E 01
274	1.5000E 01	275	1.0000E 00	276	1.0000E 00	277	0.0	278	6.4500E 00	279	0.0	280	3.0000E 00
281	0.0	282	0.0	283	0.0	284	0.0	285	0.0	286	0.0	287	0.0
288	0.0	289	0.0	290	1.0000E 00	291	9.5000E-01	292	9.0000E-01	293	8.0000E-01	294	7.0000E-01
295	6.0000E-01	296	5.0000E-01	297	4.0000E-01	298	3.0000E-01	299	2.5000E-01	300	2.2000E-01	301	1.6000E-01

PRINT OUT OF INPUT VALUES

ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,	ITEM	VALUE,
302	1.0000E-01	303	5.0000E-02	304	1.0000E-03	305	0.0	306	0.0	307	0.0	308	0.0
309	0.0	310	0.0	311	0.0	312	0.0	313	0.0	314	0.0	315	0.0
316	1.0000E 00	317	1.0000E 00	318	1.0000E 00	319	1.0000E 00	320	1.0000E 00	321	1.0000E 00	322	1.0000E 00
323	1.0000E 00	324	1.0000E 00	325	1.0000E 00	326	0.0	327	0.0	328	0.0	329	0.0
330	0.0	331	0.0	332	0.0	333	0.0	334	0.0	335	0.0	336	1.1260E-02
337	7.7300E-03	338	1.5460E-02	339	1.4940E-02	340	1.4910E-02	341	1.4910E-02	342	1.4910E-02	343	1.4910E-02
344	7.4600E-03	345	4.4700E-03	346	9.0000E-03	347	1.1290E-02	348	7.9130E-02	349	7.6940E-02	350	1.1500E-03
351	0.0	352	0.0	353	0.0	354	0.0	355	0.0	356	0.0	357	0.0
358	0.0	359	0.0	360	0.0	361	4.0000E-01	362	6.0000E-01	363	8.0000E-01	364	8.0000E-01
365	8.0000E-01	366	8.0000E-01	367	8.0000E-01	368	6.0000E-01	369	3.8000E-01	370	3.8000E-01	371	0.0
372	0.0	373	0.0	374	0.0	375	0.0	376	0.0	377	0.0	378	0.0
379	0.0	380	0.0	381	0.0	382	0.0	383	0.0	384	0.0	385	0.0
386	0.0	387	0.0	388	0.0	389	0.0	390	0.0	391	0.0	392	0.0
393	0.0	394	0.0	395	0.0	396	0.0	397	0.0	398	0.0	399	0.0
400	0.0	401	0.0	402	0.0	403	0.0	404	0.0	405	0.0	406	2.5000E-01
407	2.5000E-01	408	2.5000E-01	409	2.5000E-01	410	2.5000E-01	411	2.5000E-01	412	2.5000E-01	413	2.5000E-01
414	2.5000E-01	415	2.5000E-01	416	0.0	417	0.0	418	0.0	419	0.0	420	0.0
421	0.0	422	0.0	423	0.0	424	0.0	425	0.0	426	4.8390E-02	427	4.8390E-02
428	9.6780E-02	429	9.6780E-02	430	9.6780E-02	431	9.6780E-02	432	9.6780E-02	433	9.6780E-02	434	4.8390E-02
435	2.9030E-02	436	4.9920E-02	437	2.9860E-02	438	9.9162E-01	439	2.0830E-02	440	4.3000E-04	441	0.0
442	0.0	443	0.0	444	0.0	445	0.0	446	0.0	447	0.0	448	0.0
449	0.0	450	0.0	451	1.3600E 06	452	1.3600E 06	453	1.3600E 06	454	1.3600E 06	455	1.3600E 06
456	1.3600E 06	457	1.3600E 06	458	1.3600E 06	459	1.4076E 06	460	1.6742E 06	461	2.7190E 06	462	4.0285E 06
463	4.1000E 06	464	4.1000E 06	465	4.1000E 06	466	0.0	467	0.0	468	0.0	469	0.0
470	0.0	471	0.0	472	0.0	473	0.0	474	0.0	475	0.0	476	9.0000E 00
477	0.0	478	5.0000E 00	479	5.0000E 00	480	5.0000E 00	481	0.0	482	1.0000E 01	483	1.3000E 01
484	2.5000E 01	485	0.0	486	0.0	487	0.0	488	0.0	489	0.0	490	1.6800E 03
491	0.0	492	0.0	493	0.0	494	0.0	495	0.0	496	2.3800E 06	497	2.3800E 06
498	2.3800E 06	499	2.3800E 06	500	2.3800E 06	501	2.3800E 06	502	2.3800E 06	503	2.3800E 06	504	2.3800E 06
505	2.3953E 06	506	2.9209E 06	507	5.9924E 06	508	2.3076E 08	509	3.3163E 08	510	8.5000E 08	511	0.0
512	0.0	513	0.0	514	0.0	515	0.0	516	0.0	517	0.0	518	0.0
519	0.0	520	0.0	521	0.0	522	0.0	523	0.0	524	0.0	525	0.0
526	0.0	527	0.0	528	0.0	529	0.0	530	0.0	531	0.0	532	0.0
533	0.0	534	0.0	535	0.0	536	0.0	537	0.0	538	0.0	539	0.0
540	0.0	541	5.9400E 07	542	5.9400E 07	543	5.9400E 07	544	5.9400E 07	545	5.9400E 07	546	5.9400E 07
547	5.9400E 07	548	5.9400E 07	549	5.9400E 07	550	4.9102E 07	551	2.9486E 07	552	3.3909E 07	553	2.6000E 08
554	3.3523E 08	555	3.3523E 08	556	0.0	557	0.0	558	0.0	559	0.0	560	0.0
561	0.0	562	0.0	563	0.0	564	0.0	565	0.0	566	0.0	567	0.0
568	0.0	569	0.0	570	0.0	571	0.0	572	0.0	573	0.0	574	0.0
575	0.0	576	0.0	577	0.0	578	0.0	579	0.0	580	0.0	581	0.0
582	0.0	583	0.0	584	0.0	585	0.0	586	0.0	587	0.0	588	0.0
589	0.0	590	0.0	591	0.0	592	0.0	593	0.0	594	0.0	595	0.0
596	0.0	597	0.0	598	0.0	599	0.0	600	0.0	601	0.0	602	0.0

Locs 603 to 1200 equal 0

PROG X9900 JOB 9999 PAGE 5

VZF = 9.370107E-03 VZS = 0.0

UNIFORM DOWNWASH

DEG	STA. 1	STA. 2	STA. 3	STA. 4	STA. 5	STA. 6	STA. 7	STA. 8	STA. 9	STA.10
0	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
15	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
30	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
45	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
60	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
75	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
90	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
105	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
120	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
135	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
150	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
165	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
180	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
195	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
210	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
225	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
240	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
255	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
270	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
285	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
300	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
315	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
330	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03
345	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03	9.3701E-03

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 0
FORCE CALCULATION

REQUIRED THRUST ROUTINE

STA	1ST DEL T	LAST DEL T	*	THETA AT STA4	THRUST
1	-4.42948E 01	1.40196E 02	*	7.74248E-02	-3.74656E 02
2	-2.69724E 01	1.34480E 02	*	7.84248E-02	-2.82955F 02
3	-1.85565E 01	2.47673E 02	*	8.84247E-02	6.38284E 02
4	5.03874E 00	2.04640E 02	*	9.84247E-02	1.56214E 03
5	9.93758E 00	1.54684E 02	*	1.08425E-01	2.48730E 03
6	4.66229E 00	1.06808E 02	*	1.18425E-01	3.41201E 03
7	-3.86976E 00	6.56752E 01	*	1.28425E-01	4.33184E 03
8	-9.34867E 00	3.44547E 01	*	1.38425E-01	5.24705E 03
9	-6.30269E 00	8.41802E 00	*	1.29169E-01	4.40033E 03
10	-3.95794E 00	3.05505E 00	*	0.0	0.0

AERODYNAMIC FORCE CALCULATION

STATION 1 X/R=0.975

PSI F G	ALPHA EQUIV. ALPHA REF(L) ALPHA REF(M)	CL(REF) CL(0-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR REF. SLOPE	PSI F G	ALPHA EQUIV. ALPHA REF(L) ALPHA REF(M)	CL(REF) CL(0-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR REF. SLOPE
0.0	2.66167E-02	1.64623E-01	7.74479E-01	9.73930E-01	1.50000E 01	3.08191E-02	2.02529E-01	7.72260E-01	9.78254E-01
9.53005E-01	2.49094E-02	-3.36743E-02	-6.20979E 02	-7.23336E-02	9.55701E-01	2.94823E-02	-4.00000E-02	-6.18102E 02	-6.81313E-02
-9.66759E-02	2.49094E-02	1.66168E 00	3.14159E 00	7.95077E 00	-9.38873E-02	2.94823E-02	1.76266E 00	3.14159E 00	8.22625E 00
3.00000E 01	3.49323E-02	2.44182E-01	7.29820E-01	9.84145E-01	4.50000E 01	3.87695E-02	2.83537E-01	6.60796E-01	9.90257E-01
9.57956E-01	3.39161E-02	-4.00000E-02	-6.09666E 02	-6.40181E-02	9.59722E-01	3.80166E-02	-4.00000E-02	-5.96246E 02	-6.01808E-02
-9.15573E-02	3.39161E-02	1.85695E 00	3.14159E 00	8.37896E 00	-8.94280E-02	3.80166E-02	1.93812E 00	3.14159E 00	8.51043E 00
6.00000E 01	4.22109E-02	3.22218E-01	5.74228E-01	9.95446E-01	7.50000E 01	4.51550E-02	3.63040E-01	4.75140E-01	9.98864E-01
9.60985E-01	4.16560E-02	-4.16112E-02	-5.78756E 02	-5.67394E-02	9.61746E-01	4.47478E-02	-4.75782E-02	-5.58389E 02	-5.37953E-02
-8.66339E-02	4.16560E-02	2.00063E 00	3.14159E 00	8.77899E 00	-8.49532E-02	4.47478E-02	2.04021E 00	3.14159E 00	9.46275E 00
9.00000E 01	4.75302E-02	3.88082E-01	3.65482E-01	9.99998E-01	1.05000E 02	4.92721E-02	3.98387E-01	2.45054E-01	9.98679E-01
9.62006E-01	4.72253E-02	-4.96814E-02	-5.36533E 02	-5.14201E-02	9.61770E-01	4.90266E-02	-4.77748E-02	-5.14677E 02	-4.96782E-02
-8.43763E-02	4.72253E-02	2.05416E 00	3.14159E 00	9.70376E 00	-8.48989E-02	4.90266E-02	2.04151E 00	3.14159E 00	9.48529E 00
1.20000E 02	5.03144E-02	3.94676E-01	1.12323E-01	9.95086E-01	1.35000E 02	5.05836E-02	3.88529E-01	-3.47046E-02	9.89742E-01
[illegible]	5.00842E-02	-4.19879E-02	-4.94310E 02	-4.86359E-02	9.59795E-01	5.03199E-02	-4.00000E-02	-4.76820E 02	-4.83668E-02
-8.65259E-02	5.00842E-02	2.00313E 00	3.14159E 00	8.82215E 00	-8.92672E-02	5.03199E-02	1.94161E 00	3.14159E 00	8.51608E 00
1.50000E 02	5.00077E-02	3.76313E-01	-1.97357E-01	9.83496E-01	1.65000E 02	4.84968E-02	3.54964E-01	-3.74621E-01	9.77491E-01
9.58051E-01	4.96451E-02	-4.00000E-02	-4.63400E 02	-4.89427E-02	9.55816E-01	4.79692E-02	-4.00000E-02	-4.54964E 02	-5.04535E-02
-9.14587E-02	4.96451E-02	1.86116E 00	3.14159E 00	8.38578E 00	-9.37679E-02	4.79692E-02	1.76725E 00	3.14159E 00	8.23370E 00
1.80000E 02	4.59844E-02	3.26525E-01	-5.60706E-01	9.73067E-01	1.95000E 02	4.24601E-02	3.01247E-01	-7.41982E-01	9.71566E-01
9.53135E-01	4.52201E-02	-3.41399E-02	-4.52086E 02	-5.29659E-02	9.50108E-01	4.25226E-02	-2.39789E-02	-4.54964E 02	-5.64902E-02
-9.65406E-02	4.52201E-02	1.66631E 00	3.14159E 00	7.97577E 00	-9.96759E-02	4.22373E-02	1.56521E 00	3.14159E 00	7.64830E 00
2.10000E 02	3.80154E-02	2.96828E-01	-8.94405E-01	9.73960E-01	2.25000E 02	3.28983E-02	2.87685E-01	-9.84067E-01	9.80264E-01
9.46912E-01	4.23992E-02	-1.44966E-02	-4.63400E 02	-6.09349E-02	9.43823E-01	4.15299E-02	-6.34053E-03	-4.76820E 02	-6.60520E-02
-1.02991E-01	4.09361E-02	1.47086E 00	3.14159E 00	7.34269E 00	-1.06202E-01	3.88929E-02	1.38971E 00	3.14159E 00	7.07983E 00
2.40000E 02	2.75459E-02	2.69678E-01	-9.74473E-01	9.88913E-01	2.55000E 02	2.25580E-02	2.39173E-01	-8.41775E-01	9.96691E-01
9.41194E-01	3.92205E-02	-6.69002E-05	-4.94310E 02	-7.14045E-02	9.39405E-01	3.49994E-02	0.0	-5.14677E 02	-7.63923E-02
-1.08999E-01	3.57066E-02	1.32729E 00	3.14159E 00	6.87764E 00	-1.10805E-01	3.11898E-02	1.28785E 00	3.14159E 00	6.83362E 00
2.70000E 02	1.85851E-02	1.97217E-01	-5.91768E-01	9.99996E-01	2.85000E 02	1.61546E-02	1.47181E-01	-2.65545E-01	9.97153E-01
9.38754E-01	2.89229E-02	0.0	-5.36533E 02	-8.03652E-02	9.39357E-01	2.15413E-02	0.0	-5.58389E 02	-8.27957E-02
-1.11485E-01	2.55657E-02	1.27405E 00	3.14159E 00	6.81872E 00	-1.10856E-01	1.93934E-02	1.28681E 00	3.14159E 00	6.83250E 00
3.00000E 02	1.55202E-02	5.82677E-02	7.45433E-02	9.89711E-01	3.15000E 02	1.66133E-02	4.46114E-02	3.70478E-01	9.81228E-01
9.41104E-01	8.47653E-03	0.0	-5.78756E 02	-8.34301E-02	9.43703E-01	7.16432E-03	-6.04180E-03	-5.96246E 02	-8.23370E-02
-1.09033E-01	9.45665E-03	1.32525E 00	3.14159E 00	6.87400E 00	-1.06326E-01	8.80786E-03	1.38674E 00	3.14159E 00	7.07020E 00
3.30000E 02	1.91166E-02	7.16581E-02	5.87833E-01	9.74955E-01	3.45000E 02	2.25953E-02	1.22856E-01	7.18968E-01	9.72513E-01
9.46777E-01	1.17013E-02	-1.41184E-02	-6.09666E 02	-7.98337E-02	9.49969E-01	1.91765E-02	-2.35427E-02	-6.18102E 02	-7.63550E-02
-1.03132E-01	1.29259E-02	1.46710E 00	3.14159E 00	7.33050E 00	-9.98196E-02	1.95034E-02	1.56087E 00	3.14159E 00	7.63424E 00

Similar output for stations 2 to 10

AIRLOAD PERPENDICULAR TO CHORD LINE

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
0	0.9219E 02	0.8918E 02	0.1594E 03	0.1249E 03	0.8846E 02	0.5052E 02	0.1578E 02	-0.1198E 02	-0.1283E 02	-0.4[illegible]75E 01
15	0.1236E 03	0.1212E 03	0.2209E 03	0.1784E 03	0.1341E 03	0.8939E 02	0.4682E 02	0.1043E 02	-0.5466E 01	-0.5791E 01
30	0.1581E 03	0.1569E 03	0.2923E 03	0.2432E 03	0.1866E 03	0.1353E 03	0.8476E 02	0.3956E 02	0.5706E 01	-0.1633E 00
45	0.1938E 03	0.1927E 03	0.3672E 03	0.3119E 03	0.2455E 03	0.1838E 03	0.1258E 03	0.7255E 02	0.1893E 02	0.6789E 01
60	0.2314E 03	0.2260E 03	0.4325E 03	0.3763E 03	0.3024E 03	0.2290E 03	0.1648E 03	0.1045E 03	0.3180E 02	0.1373E 02
75	0.2685E 03	0.2530E 03	0.4846E 03	0.4275E 03	0.3475E 03	0.2646E 03	0.1958E 03	0.1302E 03	0.4300E 02	0.1935E 02
90	0.2885E 03	0.2701E 03	0.5168E 03	0.4577E 03	0.3736E 03	0.2858E 03	0.2136E 03	0.1451E 03	0.4929E 02	0.2315E 02
105	0.2906E 03	0.2751E 03	0.5248E 03	0.4622E 03	0.3763E 03	0.2881E 03	0.2155E 03	0.1464E 03	0.4981E 02	0.2344E 02
120	0.2757E 03	0.2675E 03	0.5077E 03	0.4407E 03	0.3556E 03	0.2726E 03	0.2012E 03	0.1342E 03	0.4459E 02	0.2062E 02
135	0.2534E 03	0.2486E 03	0.4685E 03	0.3969E 03	0.3154E 03	0.2417E 03	0.1737E 03	0.1112E 03	0.3496E 02	0.1541E 02
150	0.2266E 03	0.2212E 03	0.4066E 03	0.3382E 03	0.2640E 03	0.2003E 03	0.1380E 03	0.8167E 02	0.2293E 02	0.8983E 01
165	0.1947E 03	0.1871E 03	0.3361E 03	0.2730E 03	0.2127E 03	0.1544E 03	0.9924E 02	0.5107E 02	0.1074E 02	0.2689E 01
180	0.1591E 03	0.1504E 03	0.2657E 03	0.2121E 03	0.1614E 03	0.1100E 03	0.6264E 02	0.2335E 02	0.4576E 00	-0.2302E 01
195	0.1246E 03	0.1166E 03	0.2017E 03	0.1600E 03	0.1150E 03	0.7081E 02	0.3188E 02	0.1630E 01	-0.6602E 01	-0.5288E 01
210	0.9490E 02	0.8780E 02	0.1515E 03	0.1155E 03	0.7650E 02	0.3936E 02	0.8412E 01	-0.1283E 02	-0.1013E 02	-0.6192E 01
225	0.7100E 02	0.6535E 02	0.1118E 03	0.8019E 02	0.4660E 02	0.1603E 02	-0.7654E 01	-0.2070E 02	-0.1078E 02	-0.5573E 01
240	0.5298E 02	0.4916E 02	0.8159E 02	0.5395E 02	0.2508E 02	-0.5568E-01	-0.1761E 02	-0.2398E 02	-0.9931E 01	-0.3446E 01
255	0.4086E 02	0.3758E 02	0.6040E 02	0.3592E 02	0.1076E 02	-0.1035E 02	-0.2343E 02	-0.2515E 02	-0.4927E 01	-0.1839E 01
270	0.3311E 02	0.3033E 02	0.4750E 02	0.2523E 02	0.2402E 01	-0.1632E 02	-0.2693E 02	-0.2567E 02	-0.4381E 01	-0.1643E 01
285	0.2958E 02	0.2722E 02	0.4238E 02	0.2128E 02	-0.6845E 00	-0.1828E 02	-0.2879E 02	-0.1315E 02	-0.4200E 01	-0.1745E 01
300	0.3033E 02	0.2832E 02	0.4517E 02	0.2398E 02	0.1604E 01	-0.1779E 02	-0.3035E 02	-0.1552E 02	-0.6240E 01	-0.2475E 01
315	0.3635E 02	0.3398E 02	0.5665E 02	0.3471E 02	0.1022E 02	-0.1196E 02	-0.2794E 02	-0.1761E 02	-0.8834E 01	-0.4297E 01
330	0.4815E 02	0.4550E 02	0.7801E 02	0.5424E 02	0.2668E 02	0.3024E 00	-0.2081E 02	-0.1678E 02	-0.1027E 02	-0.6049E 01
345	0.6660E 02	0.6381E 02	0.1110E 03	0.8417E 02	0.5247E 02	0.2072E 02	-0.6692E 01	-0.2653E 02	-0.9337E 01	-0.6336E 01
STDY	1.4103E 02	1.3520E 02	2.4879E 02	2.0552E 02	1.5542E 02	1.0742E 02	6.6156E 01	3.5083E 01	8.6781E 00	3.1682E 00
BAYL	9.665993	9.665993	19.331985	19.331970	19.331985	19.331970	19.331985	19.331985	9.665981	5.799601

AERODYNAMIC FORCE CALCULATION

STATION 1 X/R=0.975

PSI / THETA / ALPHA	PHI / LAMBP / LAMBT	MACH / U / DFX	T / H / Q	L / D / M
0	-4.24223E 00	6.26279E-01	9.15539E 01	9.21174E 01
5.66944E 00	-7.21745E-02	8.39464E 03	1.10091E 01	4.20635E 00
1.42720E 00	9.73009E-01	-3.91508E 00	-5.00351E 01	-4.09568E 01
15	-3.98022E 00	6.64338E-01	1.22894E 02	1.23547E 02
5.66944E 00	-7.18400E-02	8.90479E 03	1.36829E 01	5.11956E 00
1.68921E 00	1.03248E 00	-5.25526E 00	-5.43134E 01	-4.46846E 01
30	-3.72618E 00	6.99876E-01	1.57111E 02	1.57903E 02
5.66944E 00	-7.08596E-02	9.38114E 03	1.72852E 01	7.03821E 00
1.94325E 00	1.08804E 00	-6.71850E 00	-5.74204E 01	-4.72780E 01
45	-3.49125E 00	7.30469E-01	1.92589E 02	1.93555E 02
5.66944E 00	-6.92998E-02	9.79120E 03	2.17559E 01	9.98762E 00
-2.17819E 00	1.13589E 00	-8.23561E 00	-7.16956E 01	-6.11114E 01
60	-3.28272E 00	7.54028E-01	2.29873E 02	2.31038E 02
5.66944E 00	-6.72670E-02	1.01070E 04	2.69261E 01	1.37187E 01
2.38671E 00	1.17278E 00	-9.82999E 00	-1.03474E 02	-9.25503E 01
75	-3.10557E 00	7.68945E-01	2.6[illegible]571E 02	2.67947E 02
5.66944E 00	-6.48998E-02	1.03069E 04	3.262[illegible]4E 01	1.81367E 01
2.56386E 00	1.19619E 00	-1.13993E 01	-1.53716E 02	-1.42578E 02
90	-2.96362E 00	7.74203E-01	2.86385E 02	2.87851E 02
5.66944E 00	-6.23595E-02	1.03774E 04	3.57512E 01	2.08968E 01
2.70581E 00	1.20452E 00	-1.22466E 01	-1.80893E 02	-1.69679E 02
105	-2.86042E 00	7.69437E-01	2.88563E 02	2.89958E 02
5.66944E 00	-5.98192E-02	1.03135E 04	3.51521E 01	2.37081E 01
2.80901E 00	1.19722E 00	-1.23397E 01	-1.78075E 02	-1.66932E 02
120	-2.79982E 00	7.54970E-01	2.73957E 02	2.75144E 02
5.66944E 00	-5.74521E-02	1.01196E 04	3.09844E 01	1.75655E 01
2.86961E 00	1.17477E 00	-1.17151E 01	-1.45378E 02	-1.34444E 02
135	-2.78632E 00	7.31785E-01	2.52053E 02	2.53019E 02
5.66944E 00	-5.54193E-02	9.80884E 03	2.60127E 01	1.37293F 01
2.88312E 00	1.13870E 00	-1.07784E 01	-1.13935E 02	-1.03338E 02
150	-2.82498E 00	7.01462E-01	2.25706E 02	2.26446E 02
5.66944E 00	-5.38595E-02	9.40240E 03	2.05883E 01	9.43936E 00
2.84445E 00	1.09148E 00	-9.65177E 00	-8.29184E 01	-7.27597E 01
165	-2.92100E 00	6.66071E-01	1.94019E 02	1.94582E 02
5.66944E 00	-5.28790E-02	8.92802E 03	1.59944E 01	6.08655E 00
2.74843E 00	1.03633E 00	-8.29678E 00	-5.38582E 01	-4.42113E 01

PSI / THETA / ALPHA	PHI / LAMBP / LAMBT	MACH / U / DFX	T / H / Q	L / D / M
180	-3.07852E 00	6.28025E-01	1.58644E 02	1.59111E 02
5.66944E 00	-5.25446E-02	8.41804E 03	1.29572E [illegible]	4.41863E 00
2.59092E 00	9.76991E-01	-6.78405E 00	-4.22416E 01	-3.31445E 01
195	-3.29846E 00	5.89921E-01	1.24145E 02	1.24571E 02
5.66944E 00	-5.28790E-02	7.90730E 03	1.09802E 01	3.81904E 00
2.37098E 00	9.17518E-01	-5.30875E 00	-3.86409E 01	-3.00943E 01
210	-3.5754[illegible] 00	5.54362E-01	9.44435E 01	9.48379E 01
5.66944E 00	-5.38595E-02	7.43067E 03	9.27161E 00	3.36377E 00
2.09397E 00	8.61963E-01	-4.03865E 00	-3.37174E 01	-2.56845E 01
225	-3.49431E 00	5.23777E-01	7.05688E 01	7.09371E 01
5.66944E 00	-5.54193E-02	7.02071E 03	7.82173E 00	3.01090E 00
1.77513E 00	8.14111E-01	-3.01771E 00	-3.00946E 01	-2.25034E 01
240	-4.22759E 00	5.00251E-01	5.25804E 01	5.29289E 01
5.66944E 00	-5.74520E-02	6.70536E 03	6.66884E 00	2.77455E 00
1.44185E 00	7.77223E-01	-2.24847E 00	-2.78935E 01	-2.06422E 01
255	-4.53722E 00	4.85385E-01	4.04812E 01	4.08168E 01
5.66944E 00	-5.98192E-02	6.50610E 03	5.84611E 00	2.62546E 00
1.13221E 00	7.53813E-01	-1.73108E 00	-2.68941E 01	-1.98574E 01
270	-4.78168E 00	4.80184E-01	3.27487E 01	3.30775E 01
5.66944E 00	-6.23595E-02	6.43639E 03	5.31157E 00	2.56317E 00
8.87750E-01	7.45477E-01	-1.40042E 00	-2.72051E 01	-2.02433E 01
285	-4.92747E 00	4.84995E-01	2.92129E 01	2.95449E 01
5.66944E 00	-6.48998E-02	6.50087E 03	5.12193E 00	2.59377E 00
7.41970E-01	7.52783E-01	-1.24922E 00	-2.88982E 01	-2.18664E 01
300	-4.95914E 00	4.99482E-01	2.99496E 01	3.02946E 01
5.66944E 00	-6.72670E-02	6.69505E 03	5.28758E 00	2.67878E 00
7.10295E-01	7.75232E-01	-1.28072E 00	-3.27602E 01	-2.55183E 01
315	-4.88228E 00	5.22657E-01	3.59267E 01	3.63098E 01
5.66944E 00	-6.92998E-02	7.00569E 03	6.03347E 00	2.95391E 00
7.87159E-01	8.11295E-01	-1.53632E 00	-3.65175E 01	-2.89397E 01
330	-4.71835E 00	5.52944E-01	4.76663E 01	4.81006E 01
5.66944E 00	-7.08596E-02	7.41166E 03	7.24265E 00	3.29719E 00
9.51090E-01	8.58514E-01	-2.03834E 00	-4.06844E 01	-3.26679E 01
345	-4.49579E 00	5.88285E-01	6.60490E 01	6.65368E 01
5.66944E 00	-7.18400E-02	7.88538E 03	8.81505E 00	3.61063E 00
1.17365E 00	9.13672E-01	-2.82443E 00	-4.53001E 01	-3.67718E 01

Similar output for stations 2 to 10

RADIAL COMPONENT OF THRUST (LBS) POSITIVE TOWARDS TIP

STA	K=0	FXN 1	2	3	4	5	6	7	8	9	10
1	-5.9933E 00	1.4266E 00	7.1841E-01	6.0169E-03	-1.0162E-01	-1.5549E-03	2.6740E-02	5.3684E-03	4.0708E-03	-3.338E-03	-8.182E-03
		-5.2728E 00	2.6432E-01	9.7916E-02	8.2377E-03	-6.4390E-02	-3.8071E-03	6.9547E-04	5.9892E-03	5.758E-03	-2.751E-03
2	-1.1742E 01	2.7452E 00	1.3525E 00	7.4291E-04	-9.6971E-02	1.4980E-04	3.1358E-02	4.5484E-03	8.9855E-03	-4.447E-03	-6.414E-03
		-1.0398E 01	5.2834E-01	5.8334E-02	1.7065E-02	-7.7444E-02	-2.7130E-03	1.2253E-03	6.1155E-03	6.847E-03	-2.324E-03
3	-2.2331E 01	5.0659E 00	2.8350E 00	-3.9948E-02	-1.6938E-02	-6.0566E-03	3.3755E-02	6.0532E-03	-9.3030E-03	-2.017E-03	-1.134E-02
		-2.0418E 01	1.0267E 00	3.9329E-02	3.1023E-02	-7.0038E-02	-8.9598E-04	4.9333E-03	6.8600E-03	-5.717E-03	-1.128E-03
4	-3.1079E 01	6.9960E 00	4.3887E 00	-8.9030E-02	2.7199E-03	-1.1367E-02	4.1702E-02	4.2686E-03	-7.0561E-03	-3.922E-03	-1.094E-02
		-2.9513E 01	1.4537E 00	1.9189E-01	2.5029E-02	-4.8444E-02	-3.2872E-03	1.4462E-02	4.8772E-03	-6.866E-04	-1.073E-03
5	-3.7692E 01	8.5831E 00	5.7538E 00	-1.1600E-01	-4.3170E-02	-6.7148E-03	2.4875E-02	6.5974E-03	-7.8097E-03	-4.093E-03	-6.037E-03
		-3.7279E 01	1.8175E 00	3.5215E-01	1.4143E-02	-4.6930E-02	-3.5235E-03	2.8522E-03	7.0115E-03	-8.716E-03	5.122E-04
6	-4.2258E 01	9.8734E 00	6.9255E 00	-1.3010E-01	-4.7910E-02	-9.2357E-03	2.7029E-02	9.6031E-03	-8.8837E-03	-5.299E-03	-6.589E-03
		-4.3669E 01	2.1445E 00	3.9245E-01	1.3426E-02	-4.4935E-02	-5.4296E-04	5.0683E-03	4.8790E-03	-1.177E-02	1.625E-03
7	-4.5065E 01	1.0898E 01	8.0927E 00	-1.4968E-01	-5.8932E-02	-1.0795E-02	3.0239E-02	1.1099E-02	-1.0054E-02	-9.508E-03	-8.680E-03
		-4.8746E 01	2.4409E 00	4.2542E-01	1.3874E-02	-4.0565E-02	5.2805E-04	2.4350E-03	1.5047E-03	-1.167E-02	4.250E-03
8	-4.6538E 01	1.1566E 01	9.3028E 00	-5.0336E-02	7.5292E-03	-9.6649E-05	3.3973E-02	3.9883E-02	9.3866E-03	-2.981E-02	-4.873E-02
		-5.2186E 01	2.8646E 00	4.9506E-01	-2.8037E-02	-8.0410E-02	-5.4826E-03	-9.1574E-03	-4.1380E-02	-5.959E-02	-9.747E-03
9	-4.6898E 01	1.1810E 01	9.8999E 00	-4.1259E-02	9.2068E-03	1.3296E-02	5.0368E-02	4.6139E-02	2.1901E-02	-1.327E-02	-4.210E-02
		-5.3292E 01	3.0527E 00	5.2353E-01	-1.1648E-02	-6.1337E-02	2.5189E-03	8.4884E-04	-2.6564E-02	-5.750E-02	-1.157E-02
10	-4.7028E 01	1.1927E 01	1.0231E 01	-5.5600E-02	9.1432E-03	1.2028E-02	4.0589E-02	3.5192E-02	1.5397E-02	-1.933E-02	-4.798E-02
		-5.3781E 01	3.1535E 00	5.5070E-01	5.2033E-04	-5.7859E-02	6.5343E-03	9.1336E-03	-2.1915E-02	-5.660E-02	-9.495E-03

Similar output for DEL T, DEL H and DEL Q

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 0
FORCE CALCULATION

RESULTANT THRUST

STA	HARMONIC 1	2	3	4	5	6	7	8	9	10
1	1.27737E 02	1.79010E 01	2.29405E 00	2.38425E 00	1.50618E 00	6.31618E-01	1.26583E-01	1.69350E-01	1.55638E-01	2.01893E-01
2	1.23762E 02	1.60620E 01	9.33825E-01	2.33376E-01	3.07831E-01	1.10971E-01	2.28106E-02	1.14982E-01	3.63666E-02	4.25365E-02
3	2.40517E 02	3.65757E 01	1.05026E 00	1.89984E 00	2.26060E-01	7.03538E-02	9.36310E-02	4.27977E-01	2.99237E-01	1.18448E-01
4	2.17408E 02	3.76795E 01	3.74791E 00	4.80602E-01	5.20043E-01	1.94070E-01	2.26690E-01	7.00670E-02	1.25719E-01	9.39419E-03
5	1.85366E 02	3.30374E 01	3.80025E 00	1.10296E 00	1.14424E-01	3.93528E-01	2.76892E-01	5.29037E-02	1.87829E-01	1.20498E-01
6	1.52455E 02	2.84474E 01	9.98385E-01	1.12068E-01	7.52121E-02	8.60029E-02	8.73217E-02	5.58237E-02	7.67542E-02	2.90647E-02
7	1.21112E 02	2.81606E 01	8.96789E-01	2.57961E-01	1.08485E-01	7.91250E-02	7.08265E-02	8.35199E-02	9.84599E-02	7.84731E-02
8	8.19432E 01	2.99830E 01	2.83697E 00	1.83740E 00	9.64766E-01	1.65469E-01	7.25643E-01	1.10109E 00	1.21705E 00	9.92021E-01
9	2.64995E 01	1.46393E 01	6.98746E-01	3.85246E-01	5.44980E-01	4.26612E-01	2.75954E-01	4.53532E-01	3.89863E-01	1.60763E-01
10	1.17395E 01	8.10025E 00	7.18555E-01	2.84564E-01	8.65758E-02	2.47201E-01	3.21026E-01	1.86949E-01	1.43336E-01	1.45928E-01

Similar output for Resultant Drag

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 0

CL VALUES

PSI	STA 1	2	3	4	5	6	7	8	9	10
0	0.2118893	0.2277159	0.2407854	0.2414187	0.2259773	0.1772902	0.0769615	-0.1151386	-0.3597993	-0.2897971
15	0.2535253	0.2745757	0.2929156	0.2978168	0.2901767	0.2599339	0.1910638	0.0586537	-0.1151859	-0.2459919
30	0.2926961	0.3193722	0.3454188	0.3572253	0.3492453	0.3334534	0.2865967	0.1926443	0.0719668	-0.0152342
45	0.3299451	0.3591189	0.3950114	0.4126235	0.4087714	0.3964856	0.3649879	0.2967786	0.2078778	0.1465254
60	0.3701174	0.3945326	0.4336425	0.4609303	0.4619592	0.4482473	0.4276873	0.3758294	0.3028404	0.2570100
75	0.4131868	0.4241195	0.4654133	0.4995095	0.5037456	0.4882802	0.4748887	0.4330661	0.3752927	0.3303238
90	0.4380819	0.4465584	0.4890792	0.5262694	0.5320082	0.5169907	0.5066098	0.4700486	0.4179951	0.3835917
105	0.4468149	0.4608626	0.5036841	0.5397485	0.5452863	0.5313599	0.5226345	0.4870681	0.4355737	0.4015406
120	0.4402876	0.4663610	0.5085456	0.5391799	0.5428403	0.5333343	0.5223432	0.4835369	0.4271185	0.3900065
135	0.4307738	0.4627149	0.5032440	0.5245090	0.5246692	0.5213289	0.5047992	0.4575282	0.3903276	0.3440225
150	0.4193533	0.4497159	0.4801562	0.4963885	0.4942943	0.4943995	0.4689826	0.4051250	0.3176880	0.2531495
165	0.3993080	0.4238802	0.4457047	0.4561353	0.4611664	0.4515746	0.4115965	0.3218582	0.1952217	0.0975007
180	0.3667613	0.3849816	0.4021063	0.4112537	0.4148996	0.3922542	0.3289050	0.1946514	-0.0006440	-0.1605779
195	0.3247473	0.3397318	0.3517155	0.3644401	0.3560903	0.3140070	0.2168055	0.0077806	-0.3105671	-0.5947424
210	0.2791353	0.2908179	0.3040420	0.3091314	0.2856857	0.2175768	0.0693310	-0.2576389	-0.8031951	-1.3528872
225	0.2329145	0.2431123	0.2551171	0.2487503	0.2064853	0.1059332	-0.1111736	-0.6158043	-1.5742435	-2.6955566
240	0.1894506	0.2005961	0.2061906	0.1880856	0.1260590	-0.0110498	-0.3078699	-1.0481720	-2.6658812	-3.2307549
255	0.1541529	0.1624074	0.1626021	0.1341145	0.0551914	-0.1144399	-0.4839814	-1.4598351	-1.8067675	-2.0540323
270	0.1267264	0.1331223	0.1299344	0.0950234	0.0059474	-0.1820341	-0.5905712	-1.6292086	-1.5378428	-1.0170660
285	0.1103765	0.1163415	0.1124763	0.0767074	-0.0127402	-0.1933302	-0.5836655	-0.5766997	-0.7642530	-0.1902400
300	0.1066859	0.1136951	0.1119218	0.0800685	0.0003610	-0.1655760	-0.5092540	-0.5221912	-0.9784962	-0.8753277
315	0.1174594	0.1245770	0.1271132	0.1044956	0.0394661	-0.0956292	-0.3674843	-0.4314473	-0.9008372	-1.2377672
330	0.1401341	0.1491999	0.1548474	0.1427034	0.0955353	-0.0067596	-0.2085366	-0.2934110	-0.6307746	-0.9575401
345	0.1724983	0.1848843	0.1924257	0.1900696	0.1597475	0.0868945	-0.0568187	-0.3394217	-0.3685544	-0.5670315

Similar output for CD and CM

AERODYNAMIC PARAMETERS

ALPHA R	V KNOTS	V/R*OMEGA	MU	ALPHA AT 270
-1.30000E 01	1.00000E 02	2.35560E-01	2.29523E-01	6.68260E 00
T S	TAU S	RHP	H	X
4.40000E 03	6.22779E 03	5.03951E 02	9.35974E 01	8.98585E 02
L	X/L	L/DE	L/QD2SIG	X/QD2SIG
6.30028E 03	2.08572E-01	-5.80223E 00	1.69977E 00	3.54524E-01
P/QD2SIGV	CT/SIG	CTP/SIG	CH/SIG	CP/SIG
6.47475E-01	6.13229E-02	-6.00446E-02	1.30447E-03	5.38776E-03
V TIP	SIG	LAMBDA		
7.16909E 02	7.19870E-02	-6.23595E-02		

PROG X9900 JOB 9999 PAGE 32

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 0
ROTOR BLADE FORCED VIBRATIONS
COUPLED FLAP----LAG----TORSION

VZ VERTICAL SHEAR IN Z DIRECTION IN UNDEFLECTED BLADE SYSTEM (LBS) POSITIVE UP

STA	K=0	1	2	3	4	5	6	7	8	9	10
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.0865E 02	-1.4717E 01	-3.4382E 00	-4.9933E-01	-1.6424E 00	-2.2498E 00	3.3332E-01	2.1358E-01	-3.7379E-02	4.213E-02	2.117E-01
		-1.7798E 00	2.1148E 01	-5.1115E 00	8.5590E-01	-2.9276E-01	1.2345E-01	5.1665E-01	6.6006E-01	2.956E-01	1.011E-01
3	3.9072E 02	-2.5170E 01	5.5852E 00	-2.8297E 00	-2.8213E 00	-2.7247E 00	6.3543E-01	3.0602E-01	-1.0434E-01	2.749E-02	1.095E-01
		-2.9092E 00	3.2208E 01	-6.1147E 00	8.6887E-01	-5.8358E-01	1.5240E-01	5.0315E-01	6.3368F-01	2.467E-01	7.042E-02
4	6.8822E 02	-5.0923E 01	1.2712E 00	-3.2112E 00	-4.7364E 00	-7.7946E-01	3.5386E-01	-3.8711E-02	3.9836E-01	-7.901E-02	-2.427E-01
		2.5645E 01	4.1746E 01	-5.2417E 00	9.6519E-01	-8.8583E-01	-1.1830E-01	-3.5869E-01	-5.6025E-01	-1.836E-01	-1.769E-01
5	9.0618E 02	-7.9250E 01	-2.2910E 01	1.3112E-01	-3.1259E 00	2.1668E 00	-6.9141E-01	-3.6883E-01	-6.9789E-02	1.643E-02	-3.552E-01
		7.7821E 01	3.7816E 01	-4.4697E 00	1.3678E 00	-6.6102E-01	-3.7621E-01	-9.4927F-01	-1.0679E 00	-7.085F-01	-1.127E-01
6	1.0553E 03	-1.0764E 02	-5.8303E 01	5.6153E 00	3.0822E-01	3.6571E 00	-8.4746E-01	-4.3791E-01	-4.2958E-01	2.794E-02	-1.302E-02
		1.3977E 02	2.5677E 01	-8.0741E-01	1.4261E 00	1.1898E-02	-4.3775E-01	-6.2469E-02	-2.0554E-01	4.913E-02	1.107E-01
7	1.1490E 03	-1.3413E 02	-9.9733E 01	1.2071E 01	1.6530E 00	3.2493E 00	-8.2381E-01	-6.5759E-02	-2.1296E-01	3.208E-02	3.904E-01
		2.0518E 02	9.4773E 00	7.1287E 00	7.1273E-01	1.8952E-01	-2.6907E-01	6.7475E-01	1.0334E 00	6.672E-01	1.314E-01
8	1.2008E 03	-1.5718E 02	-1.4600E 02	1.8570E 01	1.7675E 00	1.1322E 00	-2.6595E-01	4.0682E-01	2.9493E-01	2.518E-02	1.720E-01
		2.6990E 02	-7.1831E 00	1.4634E 01	-2.8267E-01	-1.6200E-01	4.9085E-02	8.0894E-01	1.0769E 00	3.307E-01	-8.226E-02
9	1.2230E 03	-1.7227E 02	-1.9223E 02	2.0638E 01	-9.6957E-01	-1.7966E 00	4.6828E-01	-8.4228E-02	9.7679E-02	3.711E-01	4.797E-01
		3.1936E 02	-2.5829E 01	1.8918E 01	-8.3078E-02	4.6967E-01	3.9665E-01	3.6260E-01	7.7664E-01	5.325E-01	1.073E-01
10	1.2270E 03	-1.7751E 02	-2.1269E 02	2.2103E 01	-1.3454E 00	-3.1969E 00	3.3878E-01	-1.3129E-01	-1.1058E-01	-2.410E-01	-1.836E-01
		3.3625E 02	-3.3326E 01	2.0229E 01	-9.3075E-01	-3.7005E-01	1.8840E-01	-3.5534E-01	-5.7339E-01	-2.020E-01	6.848E-02
11	1.2287E 03	-1.7982E 02	-2.2317E 02	2.3220E 01	-1.4334E 00	-3.6166E 00	7.4162E-01	2.0596E-01	9.7675E-02	-1.849E-01	-3.130E-01
		3.4383E 02	-3.7046E 01	2.0487E 01	-1.4524E 00	-6.7107E-01	5.1955E-02	-8.4531E-01	-1.2338E 00	-6.168E-01	-5.445E-02
12	1.2268E 03	-1.8110E 02	-2.2939E 02	2.4720E 01	-1.6037E 00	-4.3119E 00	9.5800E-01	2.8810E-01	1.5867E-01	-3.572E-01	-7.588E-01
		3.4613E 02	-3.8072E 01	2.1818E 01	-1.6167E 00	-7.9182E-01	7.6102E-02	-1.1953E 00	-1.9917E 00	-1.179E 00	-1.218E-01
13	1.2238E 03	-1.8157E 02	-2.3169E 02	2.5276E 01	-1.5590E 00	-4.5807E 00	1.0440E 00	3.2256E-01	1.8429E-01	-4.313E-01	-9.569E-01
		3.4624E 02	-3.8454E 01	2.2311E 01	-1.6803E 00	-8.4011E-01	8.4318E-02	-1.3401E 00	-2.3118E 00	-1.423E 00	-1.530E-01
14	1.1987E 03	-1.8181E 02	-2.3284E 02	2.5558E 01	-1.7045E 00	-4.7223E 00	1.0901E 00	3.4173E-01	1.9866E-01	-4.740E-01	-1.074E 00
		3.4593E 02	-3.8650E 01	2.2563E 01	-1.7140E 00	-8.6638E-01	8.8357E-02	-1.4202E 00	-2.4924E 00	-1.563E 00	-1.717E-01
15	1.1716E 03	-1.8183E 02	-2.3297E 02	2.5589E 01	-1.7083E 00	-4.7377E 00	1.0952E 00	3.4383E-01	2.0024E-01	-4.787E-01	-1.087E 00
		3.4465E 02	-3.8672E 01	2.2590E 01	-1.7177E 00	-8.6926E-01	8.8792E-02	-1.4290E 00	-2.5123E 00	-1.579E 00	-1.738E-01
16	1.1712E 03	-1.8183E 02	-2.3297E 02	2.5589E 01	-1.7083E 00	-4.7377E 00	1.0952E 00	3.4383E-01	2.0024E-01	-4.787E-01	-1.087E 00
		3.4463E 02	-3.8672E 01	2.2590E 01	-1.7177E 00	-8.6926E-01	8.8792E-02	-1.4290E 00	-2.5123E 00	-1.579E 00	-1.738E-01
17	1.4186E 03	-2.3772E 02	-3.1749E 02	4.2795E 01	1.6371E 00	-6.9670E 00	2.2924E 00	4.7062E-01	2.6722E-01	-2.641E-01	-1.155E 00
		4.1037E 02	-5.1382E 01	3.5702E 01	1.1374E 00	-1.4650E-02	1.9948F 00	-1.2900E 00	-2.5058E 00	-1.729E 00	-4.775E-01

Similar output for MY, BETA, Z, MX, THETA, VY, MZ, ZETA, Y

PROG X9900 JOB 9999 PAGE 42

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 1
FORCE CALCULATION

REQUIRED THRUST ROUTINE

STA	1ST DEL T	LAST DEL T	*	THETA AT STA4	THRUST
1	1.88288E 02	1.96289E 02	*	1.30151E-01	4.19269E 03
2	1.61309E 02	1.68330E 02	*	1.31151E-01	4.28496E 03
3	2.57843E 02	2.69409E 02	*	1.41151E-01	5.20631E 03
4	1.85037E 02	1.93709E 02	*	1.32399E-01	4.40018E 03
5	1.24531E 02	1.30815E 02	*	0.0	0.0
6	7.62607E 01	8.06952E 01	*	0.0	0.0
7	3.93395E 01	4.23681E 01	*	0.0	0.0
8	1.45513E 01	1.64508E 01	*	0.0	0.0
9	1.41704E 00	2.07578E 00	*	0.0	0.0
10	-4.03358E-01	-9.55707E-02	*	0.0	0.0

Output similar to iteration 0 is repeated for iterations 1 to 9

PROG X9900 JOB 9999 PAGE 366

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 10
FORCE CALCULATION

REQUIRED THRUST ROUTINE

STA	1ST DEL T	LAST DEL T	*	THETA AT STA4	THRUST
1	2.17312E 02	2.18251E 02	*	1.39692E-01	4.37497E 03
2	1.81247E 02	1.82097E 02	*	1.40692E-01	4.46682E 03
3	2.77922E 02	2.79324E 02	*	1.39964E-01	4.40000E 03
4	1.88333E 02	1.89385E 02	*	0.0	0.0
5	1.19453E 02	1.20215E 02	*	0.0	0.0
6	6.85637E 01	6.91012E 01	*	0.0	0.0
7	3.24384E 01	3.28064E 01	*	0.0	0.0
8	9.63071E 00	9.86341E 00	*	0.0	0.0
9	-1.51228E-01	-7.25628E-02	*	0.0	0.0
10	-1.00633E 00	-9.68990E-01	*	0.0	0.0

PROG X9900 JOB 9999

AERODYNAMIC FORCE CALCULATION

STATION 1 X/R=0.975

PSI F G	ALPHA EQUIV. ALPHA REF(L) ALPHA REF(M)	CL(REF) CL(0-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR REF. SLOPE	PSI F G	ALPHA EQUIV. ALPHA REF(L) ALPHA REF(M)	CL(REF) CL(0-180) L BAR	ALPHA DOT H DOT L-B SL/2	COS(YAW) PHI BAR REF. SLOPE
0.0	6.66265E-02	4.53087E-01	-1.04082E 00	9.74110E-01	1.50000E 01	6.09150E-02	4.17718E-01	-8.32206E-01	9.78397E-01
9.53002E-01	6.11462E-02	-3.36641E-02	-6.25297E 02	-7.40614E-02	9.55704E-01	5.56394E-02	-4.00000E-02	-6.07394E 02	-6.79643E-02
-9.66789E-02	6.11462E-02	3.89276E-01	3.14159E 00	7.96044E 00	-9.38834E-02	5.56394E-02	6.15229E-01	3.14159E 00	8.22650E 00
3.00000E 01	5.63648E-02	3.90950E-01	-6.22366E-01	9.84244E-01	4.50000E 01	5.25185E-02	3.68908E-01	-5.15709E-01	9.90312E-01
9.57963E-01	5.14291E-02	-4.00000E-02	-5.87971E 02	-6.24873E-02	9.59731E-01	4.80442E-02	-4.00000E-02	-5.69810E 02	-5.80099E-02
-9.15496E-02	5.14291E-02	8.96423E-01	3.14159E 00	8.37950E 00	-8.94094E-02	4.80442E-02	1.11787E 00	3.14159E 00	8.51108E 00
6.00000E 01	4.96480E-02	3.56147E-01	-3.22925E-01	9.95469E-01	7.50000E 01	4.69216E-02	3.52521E-01	-4.70105E-01	9.98870E-01
9.60991E-01	4.56347E-02	-4.16540E-02	-5.57365E 02	-5.47854E-02	9.61747E-01	4.34545E-02	-4.75919E-02	-5.54942E 02	-5.34437E-02
-8.66216E-02	4.56347E-02	1.50935E 00	3.14159E 00	8.78389E 00	-8.49494E-02	4.34545E-02	1.55637E 00	3.14159E 00	9.46433E 00
9.00000E 01	4.34134E-02	3.33999E-01	-4.39885E-01	9.99998E-01	1.05000E 02	4.12204E-02	3.15966E-01	-9.88103E-02	9.98675E-01
9.62003E-01	4.05063E-02	-4.96571E-02	-5.57405E 02	-5.33163E-02	9.61762E-01	3.89354E-02	-4.77068E-02	-5.54157E 02	-5.33061E-02
-8.63829E-02	4.05063E-02	1.65338E 00	3.14159E 00	9.70098E 00	-8.49177E-02	3.89354E-02	1.99189E 00	3.14159E 00	9.47749E 00
1.20000E 02	4.06940E-02	3.01698E-01	1.76382E-01	9.95068E-01	1.35000E 02	4.17517E-02	3.09206E-01	4.28349E-01	9.89698E-01
9.58021E-01	3.91542E-02	-4.18837E-02	-5.40082E 02	-5.29900E-02	9.59779E-01	4.10113E-02	-4.00000E-02	-5.17166E 02	-5.23479E-02
-8.65557E-02	3.91542E-02	2.24212E 00	3.14159E 00	8.81022E 00	-8.93018E-02	4.10113E-02	2.51671E 00	3.14159E 00	8.51487E 00
1.50000E 02	4.38423E-02	3.28485E-01	5.96134E-01	9.83417E-01	1.65000E 02	4.78836E-02	3.61345E-01	1.07119E 00	9.77370E-01
9.58040E-01	4.39456E-02	-4.00000E-02	-4.89901E 02	-5.16914E-02	9.55816E-01	4.87444E-02	-4.00000E-02	-4.59606E 02	-5.07282E-02
-9.14699E-02	4.39456E-02	2.70089E 00	3.14159E 00	8.38501E 00	-9.37684E-02	4.87444E-02	3.16228E 00	3.14159E 00	8.23367E 00
1.80000E 02	5.45610E-02	4.14023E-01	1.40532E 00	9.72907E-01	1.95000E 02	6.30531E-02	4.62504E-01	1.75440E 00	9.71377E-01
9.53147E-01	5.61862E-02	-3.41821E-02	-4.32426E 02	-5.03856E-02	9.50125E-01	6.35991E-02	-2.40339E-02	-4.14910E 02	-5.03596E-02
-9.65284E-02	5.61862E-02	3.52524E 00	3.14159E 00	7.97713E 00	-9.96578E-02	6.40288E-02	3.86624E 00	3.14159E 00	7.65007E 00
2.10000E 02	7.45342E-02	4.84304E-01	2.24395E 00	9.73762E-01	2.25000E 02	8.84354E-02	5.20536E-01	2.45902E 00	9.80088E-01
9.46928E-01	6.79242E-02	-1.45414E-02	-4.11998E 02	-5.20305E-02	9.43835E-01	7.44886E-02	-6.37053E-03	-4.27426E 02	-5.60412E-02
-1.02974E-01	7.02328E-02	4.31336E 00	3.14159E 00	7.34414E 00	-1.06189E-01	7.86505E-02	4.49056E 00	3.14159E 00	7.08080E 00
2.40000E 02	1.02615E-01	5.80163E-01	2.11467E 00	9.88779E-01	2.55000E 02	1.12252E-01	6.71435E-01	9.19180E-01	9.96613E-01
9.41204E-01	8.43624E-02	-8.91368E-05	-4.57993E 02	-6.24237E-02	9.39416E-01	9.82510E-02	0.0	-4.97650E 02	-7.06097E-02
-1.08929E-01	8.95340E-02	4.19323E 00	3.14159E 00	6.87836E 00	-1.10794E-01	1.02229E-01	3.24777E 00	3.14159E 00	6.83387E 00
2.70000E 02	1.15928E-01	7.72263E-01	3.11422E-02	9.99991E-01	2.85000E 02	1.15504E-01	8.78395E-01	-7.84625E-01	9.97234E-01
9.38755E-01	1.13553E-01	0.0	-5.38204E 02	-7.81358E-02	9.39351E-01	1.29444E-01	0.0	-5.76497E 02	-8.39715E-02
-1.11484E-01	1.14323E-01	2.44042E 00	3.14159E 00	6.81876E 00	-1.10862E-01	1.25751E-01	1.68058E 00	3.14159E 00	6.83236E 00
3.00000E 02	1.09038E-01	8.62229E-01	-1.85345E 00	9.89866E-01	3.15000E 02	9.77986E-02	7.56607E-01	-2.33006E 00	9.81433E-01
9.41007E-01	1.26332E-01	0.0	-6.10751E 02	-8.79539E-02	9.43692E-01	1.10670E-01	-6.01592E-03	-6.33977E 02	-8.85803E-02
-1.09040E-01	1.21441E-01	6.65011E-01	3.14159E 00	6.87383E 00	-1.06337E-01	1.06542E-01	-3.87181E-02	3.14159E 00	7.06937E 00
3.30000E 02	8.49558E-02	6.37051E-01	-2.28750E 00	9.75176E-01	3.45000E 02	7.39621E-02	5.15023E-01	-1.60125E 00	9.72722E-01
9.46768E-01	8.99786E-02	-1.40942E-02	-6.42910E 02	-8.58066E-02	9.49962E-01	7.05926E-02	-2.35217E-02	-6.38771E 02	-8.04148E-02
-1.03141E-01	8.75581E-02	-3.41521E-01	3.14159E 00	7.32973E 00	-9.98265E-02	7.01014E-02	-1.96049E-02	3.14159E 00	7.63356E 00

Similar output for stations 2 to 10

AIRLOAD PERPENDICULAR TO CHORD LINE

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
0	0.2267E 03	0.1858E 03	0.2697E 03	0.1701E 03	0.1008E 03	0.4797E 02	0.8687E 01	-0.1816E 02	-0.1550E 02	-0.5661E 01
15	0.2414E 03	0.2016E 03	0.2998E 03	0.1960E 03	0.1246E 03	0.7076E 02	0.2851E 02	-0.3247E 01	-0.1013E 02	-0.8146E 01
30	0.2529E 03	0.2156E 03	0.3311E 03	0.2262E 03	0.1492E 03	0.9499E 02	0.5101E 02	0.1571E 02	-0.2459E 01	-0.4223E 01
45	0.2611E 03	0.2244E 03	0.3564E 03	0.2517E 03	0.1732E 03	0.1170E 03	0.7255E 02	0.3538E 02	0.6139E 01	0.4410E 00
60	0.2708E 03	0.2314E 03	0.3735E 03	0.2741E 03	0.1943E 03	0.1343E 03	0.8965E 02	0.5137E 02	0.1354E 02	0.4694E 01
75	0.2794E 03	0.2310E 03	0.3781E 03	0.2850E 03	0.2055E 03	0.1435E 03	0.9969E 02	0.6247E 02	0.1874E 02	0.7747E 01
90	0.2694E 03	0.2185E 03	0.3616E 03	0.2779E 03	0.2042E 03	0.1455E 03	0.1040E 03	0.6831E 02	0.2210E 02	0.9694E 01
105	0.2502E 03	0.2049E 03	0.3400E 03	0.2627E 03	0.1948E 03	0.1406E 03	0.1021E 03	0.6838E 02	0.2302E 02	0.1041E 02
120	0.2248E 03	0.1929E 03	0.3192E 03	0.2445E 03	0.1816E 03	0.1326E 03	0.9570E 02	0.6782E 02	0.2044E 02	0.8953E 01
135	0.2098E 03	0.1836E 03	0.3023E 03	0.2257E 03	0.1646E 03	0.1196E 03	0.8320E 02	0.5125E 02	0.1509E 02	0.5906E 01
150	0.1997E 03	0.1744E 03	0.2811E 03	0.2057E 03	0.1461E 03	0.1033E 03	0.6683E 02	0.3587E 02	0.8065E 01	0.1989E 01
165	0.1956E 03	0.1668E 03	0.2622E 03	0.1863E 03	0.1302E 03	0.8584E 02	0.4928E 02	0.1956E 02	0.8471E 00	-0.1874E 01
180	0.1904E 03	0.1610E 03	0.2478E 03	0.1712E 03	0.1152E 03	0.6929E 02	0.3299E 02	0.5018E 01	-0.5085E 01	-0.4800E 01
195	0.1866E 03	0.1558E 03	0.2341E 03	0.1599E 03	0.1011E 03	0.5471E 02	0.1914E 02	-0.6338E 01	-0.8950E 01	-0.6326E 01
210	0.1872E 03	0.1543E 03	0.2307E 03	0.1518E 03	0.8944E 02	0.4179E 02	0.7070E 01	-0.1476E 02	-0.1084E 02	-0.6532E 01
225	0.1910E 03	0.1568E 03	0.2342E 03	0.1481E 03	0.8134E 02	0.3171E 02	-0.2193E 01	-0.1985E 02	-0.1090E 02	-0.5700E 01
240	0.1957E 03	0.1626E 03	0.2389E 03	0.1457E 03	0.7432E 02	0.2316E 02	-0.9061E 01	-0.2218E 02	-0.9902E 01	-0.3489E 01
255	0.1990E 03	0.1644E 03	0.2385E 03	0.1415E 03	0.6820E 02	0.1699E 02	-0.1328E 02	-0.2297E 02	-0.8652E 01	-0.1870E 01
270	0.1993E 03	0.1639E 03	0.2361E 03	0.1375E 03	0.6384E 02	0.1306E 02	-0.1601E 02	-0.2336E 02	-0.4317E 01	-0.1649E 01
285	0.2019E 03	0.1660E 03	0.2376E 03	0.1370E 03	0.6237E 02	0.1131E 02	-0.1773E 02	-0.1209E 02	-0.4171E 01	-0.1729E 01
300	0.2033E 03	0.1669E 03	0.2391E 03	0.1385E 03	0.6347E 02	0.1205E 02	-0.1839E 02	-0.1447E 02	-0.6233E 01	-0.2467E 01
315	0.2034E 03	0.1654E 03	0.2380E 03	0.1395E 03	0.6569E 02	0.1425E 02	-0.1756E 02	-0.1653E 02	-0.8804E 01	-0.4308E 01
330	0.2065E 03	0.1661E 03	0.2370E 03	0.1424E 03	0.7155E 02	0.2037E 02	-0.1331E 02	-0.2716E 02	-0.1028E 02	-0.6107E 01
345	0.2124E 03	0.1723E 03	0.2451E 03	0.1525E 03	0.8330E 02	0.3161E 02	-0.4618E 01	-0.2705E 02	-0.9798E 01	-0.6568E 01
STDV	2.1002E 02	1.8276E 02	2.8050E 02	1.9048E 02	1.2120E 02	6.9850E 01	3.3260E 01	1.0333E 01	8.1323E-02	-9.0068E-01
BAYL	9.665993	9.665993	19.331985	19.331970	19.331985	19.331970	19.331985	19.331985	9.665981	5.799601

VIBRATORY AIRLOADS PERPENDICULAR TO CHORD LINE PER UNIT LENGTH   ITERATION NO. 10

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
0	0.7901E 00	0.3109E 00	-0.5574E 00	-0.1054E 01	-0.1055E 01	-0.1132E 01	-0.1271E 01	-0.1474E 01	-0.1612E 01	-0.8208E 00
15	0.2312E 01	0.1951E 01	0.9961E 00	0.2867E 00	0.1760E 00	0.4699E-01	-0.2455E 00	-0.7024E 00	-0.1056E 01	-0.1249E 01
30	0.3510E 01	0.3394E 01	0.2619E 01	0.1845E 01	0.1449E 01	0.1300E 01	0.9100E 00	0.2780E 00	-0.2628E 00	-0.5720E 00
45	0.4358E 01	0.4313E 01	0.3928E 01	0.3166E 01	0.2691E 01	0.2440E 01	0.2032E 01	0.1296E 01	0.6267E 00	0.2313E 00
60	0.5358E 01	0.5020E 01	0.4810E 01	0.4323E 01	0.3780E 01	0.3335E 01	0.2917E 01	0.2123E 01	0.1392E 01	0.9647E 00
75	0.6248E 01	0.4991E 01	0.5051E 01	0.4889E 01	0.4361E 01	0.3812E 01	0.3436E 01	0.2697E 01	0.1930E 01	0.1491E 01
90	0.5211E 01	0.3701E 01	0.4193E 01	0.4521E 01	0.4291E 01	0.3912E 01	0.3659E 01	0.2999E 01	0.2278E 01	0.1827E 01
105	0.3221E 01	0.2287E 01	0.3077E 01	0.3734E 01	0.3807E 01	0.3661E 01	0.3561E 01	0.3003E 01	0.2373E 01	0.1950E 01
120	0.6016E 00	0.1046E 01	0.2004E 01	0.2796E 01	0.3125E 01	0.3248E 01	0.3230E 01	0.2715E 01	0.2107E 01	0.1699E 01
135	-0.9495E 00	0.9148E-01	0.1130E 01	0.1822E 01	0.2246E 01	0.2573E 01	0.2583E 01	0.2116E 01	0.1552E 01	0.1174E 01
150	-0.2002E 01	-0.8628E 00	0.2913E-01	0.7866E 00	0.1286E 01	0.1732E 01	0.1736E 01	0.1321E 01	0.8260E 00	0.4982E 00
165	-0.2629E 01	-0.1655E 01	-0.9457E 00	-0.2141E 00	0.4652E 00	0.8273E 00	0.8285E 00	0.4774E 00	0.7923E-01	-0.1679E 00
180	-0.2958E 01	-0.2294E 01	-0.1693E 01	-0.9960E 00	-0.3127E 00	-0.2889E-01	-0.1404E-01	-0.2749E 00	-0.5345E 00	-0.6723E 00
195	-0.3396E 01	-0.2791E 01	-0.2401E 01	-0.1502E 01	-0.1041E 01	-0.7820E 00	-0.7304E 00	-0.8623E 00	-0.9352E 00	-0.9355E 00
210	[illegible]	-0.2945E 01	-0.2575E 01	[illegible]	-0.1645E 01	-0.1452E 01	-0.1355E 01	-0.1298E 01	-0.1130E 01	-0.9709E 00
225	-0.2895E 01	-0.2685E 01	-0.2395E 01	-0.2191E 01	-0.2062E 01	-0.1973E 01	-0.1834E 01	-0.1561E 01	-0.1136E 01	-0.8275E 00
240	-0.2412E 01	-0.2090E 01	-0.2154E 01	-0.2317E 01	-0.2425E 01	-0.2415E 01	-0.2189E 01	-0.1682E 01	-0.1033E 01	-0.4463E 00
255	-0.2071E 01	-0.1901E 01	-0.2174E 01	-0.2534E 01	-0.2742E 01	-0.2734E 01	-0.2407E 01	-0.1723E 01	-0.9035E 00	-0.1672E 00
270	-0.2045E 01	-0.1951E 01	-0.2296E 01	-0.2738E 01	-0.2967E 01	-0.2938E 01	-0.2549E 01	-0.1743E 01	-0.4551E 00	-0.1290E 00
285	-0.1798E 01	-0.1733E 01	-0.2218E 01	-0.2764E 01	-0.3043E 01	-0.3028E 01	-0.2638E 01	-0.1160E 01	-0.4400E 00	-0.1429E 00
300	[illegible]	-0.1649E 01	-0.2149E 01	-0.2690E 01	-0.2987E 01	-0.2990E 01	-0.2672E 01	-0.1283E 01	-0.6532E 00	-0.2701E 00
315	-0.1614E 01	-0.1798E 01	-0.2197E 01	-0.2635E 01	-0.2872E 01	-0.2876E 01	-0.2629E 01	-0.1390E 01	-0.9153E 00	-0.5875E 00
330	-0.1299E 01	-0.1727E 01	-0.2251E 01	-0.2488E 01	-0.2568E 01	-0.2559E 01	-0.2409E 01	-0.1940E 01	-0.1072E 01	-0.8977E 00
345	-0.6861E 00	-0.1077E 01	-0.1833E 01	-0.1966E 01	-0.1961E 01	-0.1978E 01	-0.1959E 01	-0.1934E 01	-0.1022E 01	-0.9772E 00
AMPL	4.8022E 00	3.9865E 00	3.8130E 00	3.8264E 00	3.7019E 00	3.4700E 00	3.1652E 00	2.4712E 00	1.9927E 00	1.5995E 00
STDV	2.2650E 01	1.0907E 01	1.4510E 01	9.9532E 00	6.2695E 00	3.6132E 00	1.7204E 00	5.3440E-01	8.4133E-03	-1.5530E-01
BAYL	9.665993	9.665993	19.331985	19.331970	19.331985	19.331970	19.331985	19.331985	9.665981	5.799601

BAY AERODYNAMIC VIBRATORY PITCHING MOMENT ABOUT PITCH AXIS PER UNIT LENGTH ITERATION NO. 10

PSI	RAD. 0.975	RAD. 0.925	RAD. 0.850	RAD. 0.750	RAD. 0.650	RAD. 0.550	RAD. 0.450	RAD. 0.350	RAD. 0.275	RAD. 0.235
0	0.3100E 01	0.1515E 01	0.1041E 01	0.1229E 01	0.1144E 01	0.5511E 00	0.4172E 00	0.1098E 01	0.2631E 01	0.3259E 01
15	0.1162E 01	0.8208E 00	0.1537E 00	0.4904E 00	0.5817E 00	0.4130E 00	0.1293E 00	-0.2667E 00	0.9647E 00	0.1849E 01
30	-0.2178E 01	-0.8861E 00	-0.5592E 00	-0.1554E 00	0.1885E 00	0.2535E 00	-0.3324E 00	-0.5155E 00	-0.4428E 00	0.2260E 00
45	-0.4378E 01	-0.2881E 01	-0.1106E 01	-0.7980E 00	-0.2573E 00	-0.6477E-01	-0.3663E 00	-0.8752E 00	-0.9080E 00	-0.1206E 01
60	-0.6346E 01	-0.4208E 01	-0.2280E 01	-0.1326E 01	-0.6689E 00	-0.3057E 00	-0.4024E 00	-0.1188E 01	-0.1120E 01	-0.9387E 00
75	[illegible] 01	-0.4544E 01	-0.2788E 01	-0.1530E 01	-0.8308E 00	-0.4704E 00	-0.5308E 00	-0.1222E 01	-0.1531E 01	-0.1423E 01
90	-0.8517E 01	-0.3807E 01	-0.2711E 01	-0.1660E 01	-0.9532E 00	-0.5663E 00	-0.6249E 00	-0.1267E 01	-0.1727E 01	-0.1773E 01
105	[illegible] 01	-0.3216E 01	-0.2570E 01	-0.1752E 01	-0.1048E 01	-0.6253E 00	-0.6435E 00	-0.1338E 01	-0.1821E 01	-0.1941E 01
120	-0.3737E 01	-0.2943E 01	-0.2404E 01	-0.1702E 01	-0.9956E 00	-0.5873E 00	-0.5810E 00	-0.1418E 01	-0.1915E 01	-0.2078E 01
135	-0.2790E 01	-0.2701E 01	-0.1988E 01	-0.1482E 01	-0.7882E 00	-0.3662E 00	-0.2584E 00	-0.1457E 01	-0.1897E 01	-0.2021E 01
150	-0.1969E 01	-0.1777E 01	-0.1573E 01	-0.1123E 01	-0.5284E 00	-0.1575E 00	-0.6159E 00	-0.1556E 01	-0.1838E 01	-0.1833E 01
165	-0.5957E 00	-0.7975E 00	-0.1230E 01	-0.8142E 00	-0.2655E 00	-0.1261E-02	-0.8861E 00	-0.1550E 01	-0.1571E 01	-0.1470E 01
180	0.1099E-01	-0.3257E 00	-0.8352E 00	-0.5243E 00	-0.3974E-01	-0.4311E 00	-0.1036E 01	-0.1387E 01	-0.1159E 01	-0.9955E 00
195	[illegible]	0.1034E 00	-0.4860E 00	-0.2560E 00	-0.1197E 00	-0.5639E 00	-0.9796E 00	-0.1002E 01	-0.7017E 00	-0.6018E 00
210	0.1892E 01	0.3998E 00	-0.2606E 00	-0.8081E-01	-0.4064E 00	-0.5836E 00	-0.7277E 00	-0.5091E 00	-0.3384E 00	-0.3800E 00
225	0.2259E 01	0.7782E 00	0.4162E-01	-0.2193E 00	-0.4761E 00	-0.4763E 00	-0.3761E 00	-0.1773E 00	-0.1232E 00	0.3137E-01
240	0.2879E 01	0.1362E 01	0.5579E 00	-0.1808E 00	-0.3337E 00	-0.2379E 00	-0.8371E-02	0.7151E-01	0.2241E 00	0.4187E 00
255	[illegible] 01	0.2209E 01	0.1422E 01	0.1582E 00	-0.2491E-01	0.2965E-01	0.2984E 00	0.3847E 00	0.6052E 00	0.6635E 00
270	0.4365E 01	0.3197E 01	0.2667E 01	0.1031E 01	0.4211E 00	0.3030E 00	0.6722E 00	0.7430E 00	0.7977E 00	0.9014E 00
285	0.4654E 01	0.3671E 01	0.3284E 01	0.1526E 01	0.6877E 00	0.5015E 00	0.1343E 01	0.2095E 01	0.1568E 01	0.1222E 01
300	0.4919E 01	0.3905E 01	0.3544E 01	0.2044E 01	0.9195E 00	0.6756E 00	0.1756E 01	0.2597E 01	0.1864E 01	0.1343E 01
315	0.5293E 01	0.3954E 01	0.3322E 01	0.2527E 01	0.1146E 01	0.8303E 00	0.1770E 01	0.3156E 01	0.2348E 01	0.1695E 01
330	0.4851E 01	0.3463E 01	0.2800E 01	0.2652E 01	0.1246E 01	0.1052E 01	0.1428E 01	0.3282E 01	0.2760E 01	0.2290E 01
345	0.3972E 01	0.2587E 01	0.1959E 01	0.1946E 01	0.1402E 01	0.8271E 00	0.5549E 00	0.2298E 01	0.3333E 01	0.2761E 01
AMPL	[illegible] 00	4.2492E 00	3.1658E 00	2.2022E 00	1.2248E 00	8.3879E-01	1.4033E 00	2.4181E 00	2.6241E 00	2.6683E 00
STDY	-6.0357E 00	-4.3299E 00	-3.3105E 00	-2.9182E 00	-2.6599E 00	-2.2157E 00	-1.5055E 00	-7.3777E-01	-3.0378E-01	-8.8180E-02

AERODYNAMIC FORCE CALCULATION

STATION 1 X/R=0.975

PSI / THETA / ALPHA	PHI / LAMBP / LAMBT	MACH / U / DFX	T / H / Q	L / D / M	PSI / THETA / ALPHA	PHI / LAMBP / LAMBT	MACH / U / DFX	T / H / Q	L / D / M
0	-4.27204E 00	6.26241E-01	2.25787E 02	2.26780E 02	180	-2.94378E 00	6.28183E-01	1.89966E 02	1.90461E 02
7.77546E 00	-7.26762E-02	8.39413E 03	2.17469E 01	4.86711E 00	6.16301E 00	-5.02595E-02	8.42016E 03	1.45314E 01	4.75631E 00
[illegible]	[illegible]	-1.31921E 01	-2.83737E 01	-2.62503E 01	3.21923E 00	9.77358E-01	-1.08901E 01	-4.77212E 01	-2.84862E 01
15	-3.91083E 00	6.64395E-01	2.40371E 02	2.41375E 02	195	-3.00674E 00	5.90127E-01	1.86222E 02	1.86699E 02
[illegible]	[illegible]	8.90555E 03	2.29189E 01	6.47131E 00	6.74917E 00	-4.82237E-02	7.91007E 03	1.39845E 01	4.19724E 00
3.18790E 00	1.03265E 00	-1.35751E 01	-4.71071E 01	-4.37501E 01	3.74243E 00	9.18096E-01	-1.09757E 01	-4.34489E 01	-2.23650E 01
30	[illegible]	7.00000E-01	2.51695E 02	[illegible]	210	-3.17746E 00	5.54530E-01	1.87032E 02	1.87519E 02
6.59945E 00	[illegible]	9.38280E 03	2.53400E 01	9.51785E 00	7.59834E 00	-4.78852E-02	7.43292E 03	1.39722E 01	3.58374E 00
2.94667E 00	1.08839E 00	-1.35893E 01	-7.93935E 01	-7.45010E 01	4.42087E 00	8.62577E-01	-1.10183E 01	-4.00558E 01	-1.65534E 01
45	-3.33558E 00	7.30621E-01	2.59626E 02	2.60819E 02	225	-3.48961E 00	5.23889E-01	1.91006E 02	1.91550E 02
6.08831E 00	-6.62272E-02	9.79325E 03	2.80534E 01	1.28998E 01	8.71134E 00	-4.96783E-02	7.02221E 03	1.47481E 01	3.09466E 00
[illegible]	[illegible]	-1.32260E 01	[illegible]	-9.45557E-01	5.22173E 00	8.14656E-01	-1.10209E 01	-3.65089E 01	-1.20699E 01
60	-3.16082E 00	7.54135E-01	2.69119E 02	2.70383E 02	240	-3.91584E 00	5.00334E-01	1.95867E 02	1.96505E 02
[illegible]	[illegible]	1.01084E 04	3.05377E 01	1.54527E 01	9.93469E 00	-5.32311E-02	6.70640E 03	1.60493E 01	2.63589E 00
2.61468E 00	1.17308E 00	-1.28727E 01	-1.19686E 02	-1.11446E 02	6.01885E 00	7.77653E-01	-1.10969E 01	-3.05141E 01	-7.72440E 00
75	-3.08625E 00	7.68980E-01	2.77576E 02	2.78918E 02	255	-4.38603E 00	4.85473E-01	1.99255E 02	2.00027E 02
5.97600E 00	-6.44991E-02	1.03074E 04	3.23986E 01	1.74071E 01	1.09270E 01	-5.78403E-02	6.50727E 03	1.77296E 01	2.43945E 00
2.40976E 00	1.19626E 00	-1.25490E 01	-1.44194E 02	-1.35696E 02	6.54095E 00	7.54105E-01	-1.12949E 01	-2.13647E 01	-3.73121E 00
90	-3.07927E 00	7.74143E-01	2.67637E 02	2.68925E 02	270	-4.79647E 00	4.80199E-01	1.99403E 02	2.00317E 02
5.40011E 00	-6.47854E-02	1.03766E 04	3.11569E 01	1.67351E 01	1.14791E 01	-6.25538E-02	6.43659E 03	1.92734E 01	2.53258E 00
[illegible]	1.20430E 00	-1.17629E 01	-1.40666E 02	-1.31637E 02	6.68260E 00	7.45484E-01	-1.14841E 01	-1.61676E 01	-2.92126E 00
105	-3.08073E 00	7.69267E-01	2.48604E 02	2.49764E 02	285	-5.08816E 00	4.84947E-01	2.01814E 02	2.02862E 02
[illegible]	-6.44079E-02	1.03113E 04	2.82831E 01	1.48815E 01	1.16582E 01	-6.70044E-02	6.50023E 03	2.07823E 01	2.80186E 00
2.23083E 00	1.19671E 00	-1.10475E 01	-1.22862E 02	-1.11984E 02	6.57008E 00	7.52525E-01	-1.17835E 01	-1.33554E 01	-4.23137E 00
120	-3.06037E 00	7.54709E-01	2.23506E 02	2.24506E 02	300	-5.23465E 00	4.99423E-01	2.03018E 02	2.04138E 02
5.30374E 00	-6.27720E-02	1.01161E 04	2.46897E 01	1.27219E 01	1.13521E 01	-7.09856E-02	6.69427E 03	2.15576E 01	2.94537E 00
2.24337E 00	1.17409E 00	-1.02991E 01	-9.44659E 01	-8.22221E 01	6.11749E 00	7.74809E-01	-1.20406E 01	-1.07907E 01	-7.17709E 00
135	-3.02346E 00	7.31502E-01	2.06697E 02	2.09566E 02	315	-5.19303E 00	5.22560E-01	2.02868E 02	2.04008E 02
5.37323E 00	-6.01085E-02	9.80505E 03	2.19932E 01	1.09553E 01	1.05880E 01	-7.36852E-02	7.00439E 03	2.17951E 01	3.34383E 00
[illegible]	1.13802E 00	-1.00816E 01	-8.53101E 01	-7.15678E 01	5.39499E 00	8.10757E-01	-1.22338E 01	-7.17784E 00	-7.38850E 00
150	-2.98745E 00	7.01283E-01	1.98761E 02	1.99478E 02	330	-4.97708E 00	5.52853E-01	2.05688E 02	2.06812E 02
[illegible]	-5.69396E-02	9.39999E 03	1.89343E 01	8.54969E 00	9.57772E 00	-7.47234E-02	7.41045E 03	2.18960E 01	3.96856E 00
2.51790E 00	1.09105E 00	-1.01641E 01	-7.73729E 01	-6.26268E 01	4.60065E 00	8.58045E-01	-1.24188E 01	-1.14500E 01	-1.33104E 01
165	-2.95087E 00	6.66064E-01	1.92962E 02	1.93534E 02	345	-4.64707E 00	5.88206E-01	2.11547E 02	2.12592E 02
5.74371E 00	-5.34185E-02	8.92792E 03	1.60958E 01	6.14086E 00	8.57917E 00	-7.42423E-02	7.88432E 03	2.14893E 01	4.27960E 00
2.79285E 00	1.03629E 00	-1.05109E 01	-6.15856E 01	-4.43242E 01	3.93210E 00	9.13357E-01	-1.26355E 01	-1.99475E 01	-2.00544E 01

Similar output for stations 2 to 10

FXN RADIAL COMPONENT OF THRUST (LBS) POSITIVE TOWARDS TIP

STA	K=0	1	2	3	4	5	6	7	8	9	10
1	-1.1740E 01	-1.3666E 00	-1.8009E-01	1.9696E-01	-1.0025E-01	4.5845E-03	3.8365E-03	1.5202E-02	3.6887E-03	5.602E-03	-3.255E-02
		-9.3933E-02	-5.2542E-01	-3.6883E-03	-5.6754E-02	-8.0188E-02	-4.0488E-02	-1.2337E-02	2.2761E-04	2.533E-03	2.085E-03
2	-2.1581E 01	-2.3830E 00	-3.7674E-01	4.0377E-01	-7.0545E-02	6.4965E-03	-3.3182E-02	3.0485E-02	1.8476E-02	4.083E-03	-4.423E-02
		-3.5559E-01	-9.9501E-01	-2.2386E-01	-9.0760E-02	-1.1094E-01	-8.4108E-02	-1.3900E-02	4.8516E-03	5.441E-03	1.158E-02
3	-3.6665E 01	-3.4315E 00	-3.0938E-01	7.7082E-01	1.1081E-01	6.2140E-03	-9.4418E-02	5.4302E-02	-1.2487E-03	1.951E-03	-7.377E-02
		-1.9077E 00	-1.7440E 00	-5.9905E-01	-9.2375E-02	-1.7676E-01	-1.4407E-01	-1.7695E-02	1.0788E-02	2.381E-03	1.908E-02
4	-4.6561E 01	-3.5383E 00	-3.1726E-02	1.0012E 00	2.3522E-01	-8.0604E-03	-1.1442E-01	7.1636E-02	1.1012E-02	4.531E-03	-7.739E-02
		-4.3906E 00	-2.2181E 00	-7.2662E-01	-5.8973E-02	-1.9823E-01	-1.7542E-01	5.6434E-04	1.8231E-02	1.762E-02	2.216E-02
5	-5.2458E 01	-3.1595E 00	1.9591E-01	1.1174E 00	2.7133E-01	-1.7815E-02	-1.3730E-01	8.6519E-02	1.5204E-02	1.082E-02	-7.100E-02
		-7.2639E 00	-2.4703E 00	-7.9259E-01	-4.2963E-02	-2.1143E-01	-1.8675E-01	-2.7864E-03	2.2896E-02	1.725E-02	2.220E-02
6	-5.5608E 01	-2.6021E 00	4.3568E-01	1.1756E 00	3.2121E-01	-2.3635E-02	-1.3567E-01	9.1494E-02	1.8028E-02	1.493E-02	-6.371E-02
		-1.0129E 01	-2.5465E 00	-9.0579E-01	-4.9590E-02	-2.1237E-01	-1.9101E-01	-6.2036E-04	2.4944E-02	1.833E-02	1.956E-02
7	-5.7013E 01	-2.0391E 00	8.4425E-01	1.1978E 00	3.6099E-01	-2.2522E-02	-1.3361E-01	9.3474E-02	1.9996E-02	1.681E-02	-5.844E-02
		-1.2670E 01	-2.4918E 00	-1.0038E 00	-6.8820E-02	-1.9816E-01	-1.9264E-01	1.1730E-03	2.6047E-02	1.836E-02	1.787E-02
8	-5.7432E 01	-1.6223E 00	1.4808E 00	1.2804E 00	4.3502E-01	-3.3950E-02	-1.5909E-01	8.8886E-02	1.9655E-02	4.716E-04	-7.111E-02
		-1.4432E 01	-2.2664E 00	-1.0747E 00	-1.4504E-01	-2.2874E-01	-1.9602E-01	1.1566E-02	2.1589E-02	1.511E-02	3.459E-02
9	-5.7441E 01	-1.4802E 00	1.8348E 00	1.2892E 00	4.5961E-01	-2.5589E-02	-1.4560E-01	1.0295E-01	2.8649E-02	1.177E-02	-5.401E-02
		-1.4968E 01	-2.1325E 00	-1.0799E 00	-1.4701E-01	-2.0424E-01	-1.7589E-01	1.7773E-02	2.4630E-02	2.430E-02	3.908E-02
10	-5.7409E 01	-1.4159E 00	2.0431E 00	1.2721E 00	4.6632E-01	-2.6832E-02	-1.5709E-01	9.1956E-02	2.3334E-02	5.361E-03	-6.135E-02
		-1.5178E 01	-2.0621E 00	-1.0731E 00	-1.4022E-01	-1.9579E-01	-1.7137E-01	2.4402E-02	2.9033E-02	2.707E-02	4.159E-02

Similar output for DEL T, DEL H and DEL Q

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 10
FORCE CALCULATION

RESULTANT THRUST

STA	HARMONIC 1	2	3	4	5	6	7	8	9	10
1	3.64503E 01	1.69037E 01	3.21245E 00	2.77124E 00	2.53629E 00	8.23606E-01	4.18713E-01	1.27594E-01	1.40406E-01	6.51406E-01
2	3.19773E 01	1.33784E 01	3.93108E 00	7.97098E-01	1.17277E 00	1.08342E 00	4.27586E-01	3.45668E-01	3.24938E-02	2.77165E-01
3	6.57186E 01	2.57133E 01	6.36465E 00	2.57123E 00	1.94921E 00	1.55061E 00	5.98085E-01	3.26632E-01	5.87553E-02	5.92623E-01
4	6.86096E 01	2.11322E 01	3.96334E 00	1.56185E 00	9.16479E-01	8.02421E-01	4.86536E-01	3.21123E-01	3.31264E-01	1.53869E-01
5	6.89696E 01	1.47689E 01	2.77872E 00	4.95173E-01	4.22287E-01	5.77907E-01	3.86368E-01	1.65871E-01	9.59660E-02	1.08625E-01
6	6.70475E 01	1.08441E 01	2.00695E 00	8.67388E-01	1.34703E-01	1.49572E-01	1.62012E-01	8.28921E-02	8.27107E-02	1.71879E-01
7	6.13345E 01	1.16099E 01	1.59891E 00	7.47753E-01	4.38422E-01	3.01931E-02	6.60405E-02	3.98692E-02	4.62792E-02	1.29381E-01
8	4.46918E 01	1.63590E 01	3.31840E 00	2.24571E 00	8.31283E-01	6.92318E-01	2.96060E-01	1.24403E-01	4.30463E-01	5.51445E-01
9	1.41067E 01	9.38770E 00	8.03468E-01	4.69991E-01	6.75072E-01	6.44912E-01	4.04155E-01	2.42500E-01	3.82464E-01	4.71473E-01
10	5.65494E 00	5.56390E 00	2.63799E-01	3.03735E-01	2.26509E-01	3.37962E-01	3.52393E-01	1.87493E-01	1.86411E-01	2.07519E-01

Similar output for Resultant Drag

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 10
15 STATION CORIOLIS FORCE CALCULATION

X = RADIAL FORESHORTENING DUE TO FLAP MOTION (IN) POSITIVE TOWARD TIP

PSI	STA. 1	STA. 2	STA. 3	STA. 4	STA. 5	STA. 6	STA. 7	STA. 8	STA. 9	STA.10
0	-2.4166E-01	-2.2409E-01	-1.9747E-01	-1.6229E-01	-1.2991E-01	-1.0174E-01	-7.7720E-02	-5.7339E-02	-4.4341E-02	-3.8104E-02
15	-2.2962E-01	-2.1323E-01	-1.8836E-01	-1.5535E-01	-1.2489E-01	-9.8370E-02	-7.5673E-02	-5.6242E-02	-4.3699E-02	-3.7631E-02
30	-2.1567E-01	-2.0064E-01	-1.7704E-01	-1.4753E-01	-1.1923E-01	-9.4463E-02	-7.3209E-02	-5.4901E-02	-4.2940E-02	-3.7096E-02
45	-2.0161E-01	-1.8827E-01	-1.6794E-01	-1.4045E-01	-1.1443E-01	-9.1424E-02	-7.1518E-02	-5.4152E-02	-4.2611E-02	-3.6879E-02
60	-1.8972E-01	-1.7794E-01	-1.5996E-01	-1.3549E-01	-1.1187E-01	-9.0465E-02	-7.1508E-02	-5.4616E-02	-4.3125E-02	-3.7314E-02
75	-1.8290E-01	-1.7235E-01	-1.5625E-01	-1.3421E-01	-1.1247E-01	-9.2133E-02	-7.3548E-02	-5.6488E-02	-4.4560E-02	-3.8435E-02
90	-1.8942E-01	-1.7364E-01	-1.5842E-01	-1.3749E-01	-1.1646E-01	-9.6251E-02	-7.7282E-02	-5.9444E-02	-4.6710E-02	-4.0095E-02
105	-1.9170E-01	-1.8151E-01	-1.6596E-01	-1.4457E-01	-1.2295E-01	-1.0195E-01	-8.1936E-02	-6.2854E-02	-4.9081E-02	-4.1896E-02
120	-2.0485E-01	-1.9391E-01	-1.7718E-01	-1.5405E-01	-1.3066E-01	-1.0803E-01	-8.6505E-02	-6.5956E-02	-5.1136E-02	-4.3433E-02
135	-2.2028E-01	-2.0825E-01	-1.8986E-01	-1.6431E-01	-1.3841E-01	-1.1353E-01	-9.0097E-02	-6.8028E-02	-5.2358E-02	-4.4309E-02
150	-2.3592E-01	-2.2245E-01	-2.0187E-01	-1.7340E-01	-1.4476E-01	-1.1748E-01	-9.2152E-02	-6.8766E-02	-5.2566E-02	-4.4396E-02
165	-2.4978E-01	-2.3451E-01	-2.1123E-01	-1.7947E-01	-1.4823E-01	-1.1903E-01	-9.2368E-02	-6.8266E-02	-5.1970E-02	-4.3890E-02
180	-2.5924E-01	-2.4232E-01	-2.1659E-01	-1.8185E-01	-1.4844E-01	-1.1796E-01	-9.0800E-02	-6.6770E-02	-5.0818E-02	-4.2994E-02
195	-2.6259E-01	-2.4467E-01	-2.1747E-01	-1.8095E-01	-1.4625E-01	-1.1511E-01	-8.7946E-02	-6.4443E-02	-4.9151E-02	-4.1725E-02
210	[illegible]	-2.4144E-01	-2.1415E-01	-1.7745E-01	-1.4257E-01	-1.1144E-01	-8.4595E-02	-6.1780E-02	-4.7235E-02	-4.0258E-02
225	-2.5198E-01	-2.3468E-01	-2.0832E-01	-1.7249E-01	-1.3810E-01	-1.0747E-01	-8.1331E-02	-5.9435E-02	-4.5657E-02	-3.9078E-02
240	-2.4459E-01	-2.2786E-01	-2.0228E-01	-1.6733E-01	-1.3368E-01	-1.0384E-01	-7.8623E-02	-5.7706E-02	-4.4586E-02	-3.8299E-02
255	-2.4060E-01	-2.2382E-01	-1.9820E-01	-1.6335E-01	-1.3016E-01	-1.0110E-01	-7.6732E-02	-5.6558E-02	-4.3886E-02	-3.7794E-02
270	-2.4073E-01	-2.2343E-01	-1.9708E-01	-1.6158E-01	-1.2832E-01	-9.9520E-02	-7.5547E-02	-5.5809E-02	-4.3440E-02	-3.7474E-02
285	-2.4338E-01	-2.2562E-01	-1.9858E-01	-1.6217E-01	-1.2821E-01	-9.9058E-02	-7.5093E-02	-5.5571E-02	-4.3328E-02	-3.7393E-02
300	-2.4771E-01	-2.2944E-01	-2.0162E-01	-1.6426E-01	-1.2952E-01	-9.9855E-02	-7.5597E-02	-5.5907E-02	-4.3561E-02	-3.7570E-02
315	-2.5199E-01	-2.3315E-01	-2.0457E-01	-1.6658E-01	-1.3160E-01	-1.0165E-01	-7.6892E-02	-5.6613E-02	-4.3918E-02	-3.7809E-02
330	-2.5323E-01	-2.3439E-01	-2.0585E-01	-1.6802E-01	-1.3318E-01	-1.0316E-01	-7.8118E-02	-5.7391E-02	-4.4388E-02	-3.8153E-02
345	-2.4993E-01	-2.3154E-01	-2.0368E-01	-1.6684E-01	-1.3288E-01	-1.0339E-01	-7.8516E-02	-5.7731E-02	-4.4633E-02	-3.8349E-02

Similar output for C

COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 10
15 STATION CORIOLIS FORCE CALCULATION

XK = RADIAL FORESHORTENING DUE TO FLAP MOTION (IN) POSITIVE TOWARD TIP

	STA. 1	STA. 2	STA. 3	STA. 4	STA. 5	STA. 6	STA. 7	STA. 8	STA. 9	STA.10
STDY	-2.3136E-01	-2.1597E-01	-1.9253E-01	-1.6089E-01	-1.3072E-01	-1.0368E-01	-8.0137E-02	-5.9699E-02	-4.6238E-02	-3.9599E-02
COS 1	7.7421E-03	8.3941E-03	9.3300E-03	1.0157E-02	1.0040E-02	9.0144E-03	7.3510E-03	5.3014E-03	3.6315E-03	2.7431E-03
SIN 1	2.8711E-02	2.5022E-02	1.9428E-02	1.2128E-02	5.9420E-03	1.5171E-03	-1.0572E-03	-1.9849E-03	-1.7516E-03	-1.3976E-03
COS 2	-1.9224E-02	-1.7393E-02	-1.4673E-02	-1.1293E-02	-8.4340E-03	-6.0163E-03	-3.9301E-03	-2.1962E-03	-1.2350E-03	-8.6962E-04
SIN 2	4.6842E-03	4.6614E-03	4.6354E-03	4.5997E-03	4.4495E-03	4.0976E-03	3.5258E-03	2.7391E-03	1.9817E-03	1.5250E-03
COS 3	9.4625E-04	6.4822E-04	2.0241E-04	-3.5273E-04	-7.3417E-04	-8.7946E-04	-8.1951E-04	-6.2198E-04	-4.3559E-04	-3.3545E-04
SIN 3	6.6911E-04	4.8941E-04	2.5040E-04	6.9896E-05	-1.2611E-05	-9.7707E-05	-1.5331E-04	-1.4554E-04	-1.0209E-04	-7.3783E-05
COS 4	7.4317E-05	1.0789E-04	1.3969E-04	7.7774E-05	-7.2703E-05	-1.7544E-04	-1.8855E-04	-1.4141E-04	-9.5451E-05	-7.4127E-05
SIN 4	-5.9478E-04	-4.0767E-04	-1.3973E-04	1.2741E-04	2.1342E-04	1.6738E-04	7.2946E-05	-9.7426E-06	-3.0800E-05	-2.6771E-05
COS 5	[illegible]E-04	1.0682E-04	4.1789E-05	-1.6615E-05	-2.3685E-05	-1.5246E-06	2.0741E-05	2.8257E-05	2.4558E-05	2.0138E-05
SIN 5	6.3757E-04	3.3050E-04	1.7742E-04	2.4910E-05	-2.8342E-05	-1.7290E-05	1.2810E-05	2.9959E-05	3.4090E-05	3.1364E-05
COS 6	6.5263E-05	4.2205E-05	1.5983E-05	1.6839E-05	3.6044E-05	3.5453E-05	1.2516E-05	-1.6862E-05	-2.3321E-05	-2.0271E-05
SIN 6	[illegible]E-05	5.3252E-05	8.1489E-05	1.0345E-04	8.3864E-05	3.5370E-05	-1.0341E-05	-3.0304E-05	-2.4222E-05	-1.8078E-05
COS 7	-3.1879E-05	-2.5164E-05	-1.6938E-05	-1.3932E-05	-1.7211E-05	-1.6296E-05	-7.5223E-06	4.1298E-06	8.9236E-06	8.0171E-06
SIN 7	-6.1408E-05	-2.6142E-05	1.8597E-05	3.5529E-05	-2.5978E-06	-3.4293E-05	-2.5198E-05	5.7972E-06	2.0765E-05	2.0777E-05
COS 8	[illegible]E-05	-1.2666E-05	3.3379E-06	1.4330E-05	6.2635E-06	-8.9640E-06	-1.0421E-05	-2.4835E-07	6.0368E-06	6.2274E-06
SIN 8	[illegible]E-06	1.6342E-06	-4.2717E-06	-7.4605E-06	-3.3279E-06	1.0381E-06	1.6143E-06	-2.3966E-07	4.5573E-07	1.2436E-06
COS 9	[illegible]E-05	-7.0333E-06	4.6591E-06	8.6129E-06	-2.1706E-06	-8.9705E-06	-4.2319E-06	4.2145E-06	9.1844E-06	9.2645E-06
SIN 9	[illegible]E-05	5.9346E-06	-4.2684E-06	-6.1393E-06	2.6921E-06	2.5382E-06	-1.2682E-06	-2.1369E-06	1.5376E-06	2.8741E-06
COS10	2.2774E-05	1.9506E-05	1.4380E-05	9.0152E-06	4.7833E-06	-2.1855E-06	-5.0416E-06	-7.1650E-07	6.2461E-06	7.4838E-06
SIN10	1.7941E-05	5.4389E-06	-9.7503E-06	-9.8596E-06	7.8877E-06	1.0130E-05	-1.2113E-06	-5.8316E-06	-3.9088E-06	-3.0454E-06

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COMPREHENSIVE ROTOR ANALYSIS ITERATION NO. 10

CL VALUES

PSI	STA 1	2	3	4	5	6	7	8	9	10
0	0.5303766	0.4826893	0.4146039	0.3354146	0.2642149	0.1749769	0.0466083	-0.1612621	-0.4277620	-0.3220495
15	0.5011169	0.4620116	0.4019180	0.3311042	0.2732249	0.2091801	0.1189302	-0.0242471	-0.1989846	-0.3357927
30	0.4723083	0.4420745	0.3938448	0.3342432	0.2813244	0.2361671	0.1742113	0.0764281	-0.0399311	-0.1298040
45	0.4469895	0.4202722	0.3847253	0.3337552	0.2890064	0.2530300	0.2110393	0.1448963	0.0658212	0.0049131
60	0.4343677	[illegible]	0.3747008	0.3353081	0.2963302	0.2625768	0.2325640	0.1846361	0.1283134	0.0862970
75	0.4309481	0.3877679	0.3630696	0.3322864	0.2969919	0.2638606	0.2408780	0.2067114	0.1621407	0.1302919
90	0.4097503	0.3614874	0.3417528	0.3184832	0.2893659	0.2614407	0.2446787	0.2190304	0.1845835	0.1572446
105	0.3846866	0.3426872	0.3251792	0.3049750	0.2800974	0.2567844	0.2446420	0.2239967	0.1972362	0.1737880
120	0.3585229	0.3351256	0.3179010	0.2965996	0.2740529	0.2557769	0.2441302	0.2214835	0.1905620	0.1636211
135	0.3555101	0.3399383	0.3220595	0.2946714	0.2696646	0.2532320	0.2364501	0.2049561	0.1618448	0.1246323
150	0.3676179	0.3521817	0.3284405	0.2973623	0.2680056	0.2488729	0.2202081	0.1701674	0.1028972	0.0456657
165	0.3942575	0.3740574	0.3429655	0.3053787	0.2753282	0.2430542	0.1953990	0.1128102	0.0013512	-0.0921264
180	0.4352404	0.4073787	0.3690840	0.3245033	0.2871257	0.2366364	0.1610848	0.0258422	-0.1617070	-0.3218448
195	0.4823605	0.4487898	0.4012629	0.3552133	0.3020383	0.2299175	0.1148466	-0.1032415	-0.4226605	-0.7108312
210	0.5473890	0.5060323	0.4557159	0.3963966	0.3219923	0.2172140	0.0419032	-0.3062302	-0.8611091	-1.4167347
225	0.6261933	0.5806747	0.5288317	0.4509467	0.3502015	0.2014682	-0.0584684	-0.6029868	-1.5811987	-2.7066355
240	0.7058206	0.6667987	0.6041542	0.5062286	0.3743517	0.1745927	-0.1828675	-0.9801102	-2.6260319	-3.2049561
255	0.7671121	0.7241306	0.6531894	0.5399849	0.3844931	0.1438567	-0.2962775	-1.3420954	-3.4003601	-2.0948143
270	0.7884232	0.7426692	0.6678476	0.5459912	0.3787451	0.1180732	-0.3646814	-1.4900513	-1.5375252	-1.1315327
285	0.7859719	0.7396449	0.6599766	0.5332193	0.3625534	0.1023332	-0.3654897	-0.5501916	-0.7951809	-0.2166957
300	0.7495111	0.7016947	0.6230509	0.5005646	0.3386247	0.1020341	-0.3096505	-0.4978380	-1.0058212	-0.9145508
315	0.6865402	0.6331980	0.5595717	0.4479703	0.3053006	0.1051314	-0.2236820	-0.4067099	-0.9118266	-1.2774839
330	0.6227024	0.5643882	0.4886624	0.3927338	0.2775249	0.1198317	-0.1259329	-0.4874957	-0.6337583	-0.9801991
345	0.5645940	0.5124087	0.4363625	0.3554096	0.2651187	0.1456807	-0.0320956	-0.3391269	-0.3814802	-0.5870019

Similar output for CD and CM

AERODYNAMIC PARAMETERS

ALPHA R	V KNOTS	V/R*OMEGA	MU	ALPHA AT 270
-1.30000E 01	1.00000E 02	2.35560E-01	2.29523E-01	6.68260E 00
T S	TAU S	RHP	H	X
4.40000E 03	6.22779E 03	5.03951E 02	9.35974E 01	8.98585E 02
L	X/L	L/DE	L/QD2SIG	X/QD2SIG
4.30828E 03	2.08572E-01	5.80223E 00	1.69977E 00	3.54524E-01
P/QD2SIGV	CT/SIG	CTP/SIG	CH/SIG	CP/SIG
6.47475E-01	6.13229E-02	6.00446E-02	1.30447E-03	5.38776E-03
V TIP	SIG	LAMBDA		
7.16989E 02	7.19870E-02	-6.23595E-02		

COMPREHENSIVE ROTOR ANALYSIS
ROTOR BLADE FORCED VIBRATIONS
COUPLED FLAP---LAG----TORSION

ITERATION NO. 10

VZ VERTICAL SHEAR IN Z DIRECTION IN UNDEFLECTED BLADE SYSTEM (LBS) POSITIVE UP

STA	K=0	1	2	3	4	5	6	7	8	9	10
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.2500E 02	8.6290E 00	1.8719E 01	-1.6189E 00	1.5262E 00	-9.2991E-01	-6.0818E-01	1.6305E-01	2.0902E-01	1.211E-01	6.869E-03
		-2.9944E 01	-1.0151E 00	-2.6191E 00	2.4066E 00	-1.1214E 00	8.7956E-02	6.0503E-01	-4.6943E-02	-2.111E-01	-2.242E-01
3	4.1312E 02	1.3014E 01	2.7772E 01	-3.2772E 00	4.6932E-01	-9.7298E-01	-3.1097E-02	6.4344E-02	-3.1711E-02	1.448E-01	-8.997E-02
		-5.4597E 01	2.4716E-01	-5.4181E-01	2.8898E 00	-1.7284E 00	3.8032E-01	5.2497E-01	-9.5054E-02	-1.663E-01	-2.203E-01
4	7.0375E 02	7.9326E 00	3.8569E 01	-4.5895E 00	-2.8991E 00	-2.8002E-01	6.9501E-01	-8.7938E-02	1.3686E-01	-1.059E-01	4.984E-02
		-8.3892E 01	-1.0620E 00	2.1469E 00	1.6274E 00	-1.1852E 00	8.6439E-02	-2.5337E-01	3.3170E-02	2.997E-01	3.227E-01
5	9.0362E 02	-7.3142E 00	4.4569E 01	-2.9183E 00	-3.6980E 00	7.2593E-01	1.7907E-01	-6.5029E-02	-3.1277E-01	-2.429E-01	-9.072E-02
		-8.9494E 01	-5.7345E 00	7.2184E-01	-5.8215E-01	-1.9371E-01	-6.8666E-01	-9.8396E-01	8.9178E-02	4.188E-02	2.711E-01
6	1.0333E 03	-2.6058E 01	5.0632E 01	8.1278E-01	-1.7599E 00	1.1259E 00	-3.8726E-01	5.0703E-02	-2.2098E-01	-4.307E-02	-1.698E-01
		-7.5931E 01	-1.2534E 01	-9.6523E-01	-2.0377E 00	6.7060E-01	-1.1791E 00	-3.1494E-01	5.4803E-02	-9.726E-02	-2.538E-01
7	1.1104E 03	-4.4901E 01	5.4909E 01	5.0215E 00	3.1377E-01	7.6919E-01	-1.0677E 00	2.5655E-01	1.9317E-01	2.391E-01	1.413E-02
		-4.6713E 01	-2.0556E 01	-8.0148E-01	-2.2579E 00	7.4319E-01	-8.9612E-01	5.8259E-01	-1.8911E-02	-1.374E-01	-3.244E-01
8	1.1494E 03	-6.2067E 01	5.3325E 01	8.6128E 00	2.4555E 00	-1.4045E-01	-1.0516E 00	2.7311E-01	4.0162E-01	1.923E-01	1.832E-01
		-7.7159E 00	-2.9285E 01	-3.0811E-01	-1.5366E 00	5.2105E-02	-2.4808E-02	9.7356E-01	-6.0111E-02	2.283E-02	1.347E-01
9	1.1620E 03	-7.4415E 01	4.3346E 01	8.2884E 00	2.7949E 00	-5.4358E-01	3.8489E-01	1.5770E-01	1.5809E-01	3.061E-01	5.124E-01
		2.6949E 01	-4.1038E 01	1.5894E-01	1.2921E 00	6.1292E-01	8.9948E-01	2.8080E-01	1.7639E-01	3.522E-01	4.153E-02
10	1.1643E 03	-7.8552E 01	3.6333E 01	8.4901E 00	3.1440E 00	-9.9557E-01	2.7049E-01	-4.1547E-01	-2.3984E-01	-2.738E-01	-2.364E-01
		3.9316E 01	-4.6867E 01	-9.1175E-02	1.5417E 00	-4.1612E-01	5.4027E-01	-1.9973E-01	7.6208E-02	1.517E-02	6.575E-02
11	1.1649E 03	-8.0400E 01	3.1815E 01	9.1639E 00	3.5428E 00	-1.0373E 00	7.5944E-01	-1.6150E-01	-1.8204E-01	-2.341E-01	-1.749E-01
		4.4387E 01	-4.9803E 01	-3.2908E-01	1.3988E 00	-8.5903E-01	5.0002E-01	-6.0136E-01	-8.6946E-02	-1.055E-01	4.482E-02
12	1.1630E 03	-8.0968E 01	3.2751E 01	9.7552E 00	3.9630E 00	-1.2387E 00	9.7523E-01	-2.3546E-01	-2.9763E-01	-4.568E-01	-4.227E-01
		4.4418E 01	-5.1189E 01	-3.4095E-01	1.5590E 00	-1.0140E 00	6.6265E-01	-8.4800E-01	-1.3405E-01	-1.902E-01	1.247E-01
13	1.1599E 03	-8.1176E 01	3.3090E 01	9.9747E 00	4.1214E 00	-1.3163E 00	1.0618E 00	-2.6473E-01	-3.4601E-01	-5.526E-01	-5.336E-01
		4.4288E 01	-5.1703E 01	-3.4485E-01	1.5340E 00	-1.0770E 00	7.2544E-01	-9.5124E-01	-1.5519E-01	-2.289E-01	1.585E-01
14	1.1348E 03	-8.1281E 01	3.3259E 01	1.0087E 01	4.2030E 00	-1.3587E 00	1.1090E 00	-2.8099E-01	-3.7372E-01	-6.095E-01	-6.014E-01
		4.2928E 01	-5.1973E 01	-3.4427E-01	1.6596E 00	-1.1157E 00	7.6130E-01	-1.0116E 00	-1.6845E-01	-2.536E-01	1.785E-01
15	1.1077E 03	-8.1294E 01	3.3277E 01	1.0099E 01	4.2116E 00	-1.3638E 00	1.1142E 00	-2.8286E-01	-3.7689E-01	-6.163E-01	-6.096E-01
		4.1601E 01	-5.2005E 01	-3.4356E-01	1.6738E 00	-1.1211E 00	7.6589E-01	-1.0190E 00	-1.7019E-01	-2.568E-01	1.809E-01
16	1.1073E 03	-8.1294E 01	3.3277E 01	1.0099E 01	4.2118E 00	-1.3638E 00	1.1142E 00	-2.8286E-01	-3.7689E-01	-6.163E-01	-6.096E-01
		4.1581E 01	-5.2005E 01	-3.4356E-01	1.6738E 00	-1.1211E 00	7.6589E-01	-1.0190E 00	-1.7019E-01	-2.568E-01	1.809E-01
17	1.3738E 03	-1.2094E 02	6.9583E 01	1.4460E 01	5.2339E 00	-3.6072E 00	3.2017E 00	-1.7941E-01	-4.4272E-01	-6.163E-01	-6.074E-01
		1.7062E 02	-4.2474E 01	-6.0638E 00	-2.6732E 00	3.0859E 00	3.6264E 00	-1.6902E 00	-2.9443E-01	-3.485E-01	8.942E-02

Similar output for MY, BETA, Z, MX, THETA, VY, MZ, ZETA, Y

VZ VERTICAL SHEAR IN Z DIRECTION IN UNDEFLECTED BLADE SYSTEM (LBS) POSITIVE UP

PSI	STA 2	3	4	5	6	7	8	9	10
0	2.62169E 01	3.70618E 01	3.94212E 01	3.08315E 01	2.39722E 01	1.57447E 01	2.18478E 00	-1.90105E 01	-3.24756E 01
15	1.49471E 01	2.12823E 01	1.60658E 01	6.25868E-01	-1.04161E 01	-1.70475E 01	-2.42363E 01	-3.81110E 01	-4.83988E 01
30	4.37184E-01	-1.00053E-01	-1.31990E 01	-3.22957E 01	-4.77602E 01	-5.49049E 01	-5.88901E 01	-6.52409E 01	-7.04128E 01
45	-1.73493E 01	-2.67544E 01	-4.54477E 01	-6.71400E 01	-8.45453E 01	-9.02276E 01	-8.71184E 01	-8.34759E 01	-8.38746E 01
60	-3.26566E 01	-5.24168E 01	-8.31808E 01	-1.03028E 02	-1.13268E 02	-1.12146E 02	-9.90983E 01	-8.25422E 01	-7.51060E 01
75	-4.27695E 01	-7.36665E 01	-1.14695E 02	-1.29887E 02	-1.29437E 02	-1.15459E 02	-8.76131E 01	-5.63087E 01	-4.34572E 01
90	-4.56445E 01	-8.36883E 01	-1.28747E 02	-1.38052E 02	-1.26143E 02	-9.92394E 01	-5.78960E 01	-1.38163E 01	5.74277E 00
105	-4.24351E 01	-7.91857E 01	-1.21329E 02	-1.25429E 02	-1.05104E 02	-6.77320E 01	-1.43440E 01	3.65560E 01	5.92420E 01
120	-3.78947E 01	-6.64270E 01	-9.49769E 01	-9.34579E 01	-6.92012E 01	-2.66034E 01	2.88439E 01	8.26016E 01	1.05118E 02
135	-3.09045E 01	-5.07592E 01	-6.16268E 01	-4.99078E 01	-2.17452E 01	2.07275E 01	7.02305E 01	1.15772E 02	1.33472E 02
150	-1.87166E 01	-3.01951E 01	-2.79388E 01	-6.91775E 00	2.43060E 01	6.35787E 01	1.02355E 02	1.32270E 02	1.41951E 02
165	-1.72011E 00	-4.11136E 00	4.87118E 00	2.58202E 01	5.67377E 01	8.92983E 01	1.15938E 02	1.31336E 02	1.34177E 02
180	1.34884E 01	1.91148E 01	3.36827E 01	5.04605E 01	7.21955E 01	9.29734E 01	1.08443E 02	1.13403E 02	1.11019E 02
195	2.18036E 01	3.31047E 01	4.99260E 01	6.56503E 01	7.82773E 01	8.56122E 01	8.63699E 01	7.83234E 01	7.22049E 01
210	2.06493E 01	3.33860E 01	5.35532E 01	6.88614E 01	7.60929E 01	7.25224E 01	5.81317E 01	3.60876E 01	2.43130E 01
225	1.20609E 01	2.50454E 01	4.98677E 01	6.43571E 01	6.44253E 01	5.00247E 01	2.47608E 01	-5.50960E 00	-1.75758E 01
240	5.35982E 00	1.98748E 01	4.35542E 01	5.36799E 01	4.63762E 01	2.34376E 01	-7.76838E 00	-3.66528E 01	-4.71821E 01
255	6.52643E 00	2.18563E 01	4.14996E 01	4.31667E 01	2.81856E 01	1.78482E 00	-2.88112E 01	-5.69451E 01	-6.50222E 01
270	1.28802E 01	2.92619E 01	4.45943E 01	4.07160E 01	2.20118E 01	-7.46297E 00	-4.13031E 01	-6.87639E 01	-7.26691E 01
285	1.64928E 01	3.54818E 01	5.50176E 01	5.06747E 01	2.72754E 01	-8.51903E 00	-4.72128E 01	-6.64077E 01	-7.06756E 01
300	2.18371E 01	4.26056E 01	6.56694E 01	6.25882E 01	3.76014E 01	1.87473E-01	-3.89146E 01	-5.54393E 01	-5.97500E 01
315	3.09245E 01	5.04641E 01	6.93504E 01	6.62315E 01	4.80607E 01	1.90047E 01	-1.60886E 01	-3.73337E 01	-4.55565E 01
330	3.40435E 01	5.15220E 01	6.75674E 01	6.66130E 01	5.38160E 01	3.19122E 01	3.91179E 00	-2.28462E 01	-3.05483E 01
345	3.24234E 01	4.72422E 01	5.65009E 01	5.58369E 01	4.82849E 01	3.25324E 01	1.01252E 01	-1.78960F 01	-2.45347E 01
AMPL	3.98440E 01	6.76052E 01	9.90488E 01	1.03456E 02	1.03857E 02	1.04216E 02	1.07518E 02	1.07873E 02	1.12913E 02
STDY	2.25000E 02	4.13119E 02	7.03747E 02	9.03620E 02	1.33327E 03	1.11035E 03	1.14940E 03	1.16283E 03	1.16427F 03

PSI	STA 11	12	13	14	15	16	17
0	-3.69090E 01	-3.61745E 01	-3.59410E 01	-3.58483E 01	-3.58408E 01	-3.58408E 01	-3.37113E 01
15	-5.51481E 01	-5.46924E 01	-5.45534E 01	-5.48179E 01	-5.51538E 01	-5.51589E 01	-2.24394E 01
30	-7.52518E 01	-7.64760E 01	-7.70007E 01	-7.79178E 01	-7.86084E 01	-7.86184E 01	-2.95046E 01
45	-8.47489E 01	-8.74027F 01	-8.84924E 01	-8.99718E 01	-9.09690E 01	-9.09831E 01	-3.04581E 01
60	-7.22631E 01	-7.48440E 01	-7.59037E 01	-7.75611E 01	-7.87649E 01	-7.87821E 01	-1.26621E 00
75	-3.68537E 01	-3.90591E 01	-4.00224E 01	-4.17752E 01	-4.31079E 01	-4.31271E 01	5.13397E 01
90	1.53136E 01	1.47648E 01	1.44351E 01	1.29777E 01	1.16383E 01	1.16185E 01	1.13721E 02
105	7.07771E 01	7.14576E 01	7.15711E 01	7.03794E 01	6.91105E 01	6.90913E 01	1.72158E 02
120	1.16107E 02	1.18023E 02	1.18622E 02	1.17826E 02	1.16722E 02	1.16705E 02	2.21145F 02
135	1.41522E 02	1.43580E 02	1.44247E 02	1.43691E 02	1.42801E 02	1.42787E 02	2.49349E 02
150	1.45694E 02	1.47139E 02	1.47589E 02	1.47171E 02	1.46538E 02	1.46528E 02	2.51246E 02
165	1.33821E 02	1.35056E 02	1.35455E 02	1.35308E 02	1.34987E 02	1.34982E 02	2.31633E 02
180	1.08430E 02	1.10112E 02	1.10729E 02	1.11039E 02	1.11074E 02	1.11074E 02	1.87647E 02
195	6.77953E 01	6.91580E 01	6.97275E 01	7.03704E 01	7.07485E 01	7.07536E 01	1.09418E 02
210	1.82471E 01	1.72600E 01	1.69314E 01	1.73825E 01	1.80188E 01	1.80287E 01	9.44407E 00
225	-2.32165E 01	-2.45727E 01	-2.49812E 01	-2.42928E 01	-2.33873E 01	-2.33732E 01	-7.29159E 01
240	-5.01306E [illegible]	-5.10273E 01	-5.12296E 01	-5.02200E 01	-4.90908E 01	-4.90736E 01	-1.35698E 02
255	-6.58596E 01	-6.63635E [illegible]	-6.64028E 01	-6.51672E 01	-6.38931E 01	-6.38739E 01	-1.97227E 02
270	-7.33913E 01	-7.40411E 01	-7.41214E 01	-7.28514E 01	-7.15322E 01	-7.15123E 01	-2.48492E 02
285	-7.14305E 01	-7.24310F 01	-7.26875E 01	-7.15783E 01	-7.03192E 01	-7.03000E 01	-2.58062E 02
300	-6.06773E 01	-6.02378E 01	-5.99060E 01	-5.85824E 01	-5.74144E 01	-5.73972E 01	-2.18907E 02
315	-4.84558F 01	-4.86472E 01	-4.86433E 01	-4.77329E 01	-4.67995E 01	-4.67855E 01	-1.68681E 02
330	-3.51684E 01	-3.44982E 01	-3.42042E 01	-3.34152E 01	-3.27397E 01	-3.27298E 01	-1.15624E 02
345	-2.82027E 01	-2.60830E 01	-2.52172E 01	-2.44121E 01	-2.40168E 01	-2.40116E 01	-6.41129E 01
AMPL	1.15221E 02	1.17271E 02	1.18041E 02	1.18571E 02	1.18754E 02	1.18756E 02	2.54654E 02
STDY	1.16488E 03	1.16300E 03	1.15992E 03	1.13480E 03	1.10773E 03	1.10730E 03	1.37376E 03

Similar output for MY, BETA, Z, MX, THETA, VY, MZ, ZETA, Y, VXB, VZB, MXB, MYB AND MZB

Y - VIBRATORY LAG DEFLECTION IN DISC PLANE SYSTEM (IN) POSITIVE TOWARD LEADING EDGE

PSI	STA 2	3	4	5	6	7	8	9	10
0	4.05961E-03	9.02563E-03	1.35543E-02	1.54590E-02	1.54229E-02	1.39116E-02	1.08932E-02	7.50349E-03	5.42647E-03
15	1.42026E-01	1.31437E-01	1.15669E-01	9.78098E-02	7.87522E-02	5.94525E-02	4.03670E-02	2.62527E-02	1.89419E-02
30	2.72420E-01	2.46885E-01	2.11708E-01	1.75110E-01	1.37962E-01	1.01584E-01	6.70114E-02	4.27673E-02	3.06712E-02
45	3.84824E-01	3.45774E-01	2.93440E-01	2.40539E-01	1.87739E-01	1.36633E-01	8.89131E-02	5.62495E-02	4.02243E-02
60	4.69770E-01	4.19523E-01	3.52849E-01	2.86849E-01	2.22261E-01	1.60478E-01	1.03419E-01	6.49924E-02	4.63940E-02
75	5.19099E-01	4.60809E-01	3.83816E-01	3.08723E-01	2.36545E-01	1.68720E-01	1.07342E-01	6.69322E-02	4.76587E-02
90	5.28672E-01	4.65681E-01	3.82973E-01	3.03655E-01	2.29140E-01	1.60799E-01	1.00563E-01	6.20053E-02	4.39827E-02
105	4.98612E-01	4.35838E-01	3.53703E-01	2.75763E-01	2.03917E-01	1.39769E-01	8.51761E-02	5.16032E-02	3.63514E-02
120	4.32763E-01	3.75354E-01	3.00901E-01	2.30968E-01	1.67441E-01	1.12062E-01	6.65119E-02	3.95740E-02	2.76889E-02
135	3.37654E-01	2.90913E-01	2.31051E-01	1.75576E-01	1.25759E-01	8.29318E-02	4.83647E-02	2.84346E-02	1.98223E-02
150	2.23082E-01	1.90969E-01	1.50357E-01	1.13447E-01	8.08619E-02	5.32351E-02	3.11262E-02	1.84044E-02	1.29083E-02
165	9.98150E-02	8.42023E-02	6.45277E-02	4.70590E-02	3.24105E-02	2.07302E-02	1.19031E-02	7.04997E-03	5.01671E-03
180	-2.37802E-02	-2.32879E-02	-2.25319E-02	-2.12258E-02	-1.88479E-02	-1.52312E-02	-1.05886E-02	-6.81087E-03	-4.83451E-03
195	-1.43618E-01	-1.28556E-01	-1.08808E-01	-8.91758E-02	-6.95692E-02	-5.03228E-02	-3.21775E-02	-1.99995E-02	-1.41704E-02
210	-2.57616E-01	-2.28530E-01	-1.90040E-01	-1.52108E-01	-1.15355E-01	-8.08901E-02	-5.01774E-02	-3.06080E-02	-2.15503E-02
225	-3.59855E-01	-3.18319E-01	-2.62572E-01	-2.07487E-01	-1.54873E-01	-1.06749E-01	-6.51372E-02	-3.93421E-02	-2.75749E-02
240	-4.41067E-01	-3.89778E-01	-3.20900E-01	-2.53109E-01	-1.88827E-01	-1.30482E-01	-8.01709E-02	-4.87305E-02	-3.42710E-02
255	-4.91610E-01	-4.35462E-01	-3.60344E-01	-2.86552E-01	-2.16184E-01	-1.51358E-01	-9.42784E-02	-5.79087E-02	-4.09473E-02
270	-5.08284E-01	-4.51161E-01	-3.75197E-01	-3.00627E-01	-2.28936E-01	-1.62052E-01	-1.02311E-01	-6.35411E-02	-4.51740E-02
285	-4.92359E-01	-4.35992E-01	-3.61420E-01	-2.89135E-01	-2.20774E-01	-1.57783E-01	-1.01323E-01	-6.36858E-02	-4.55458E-02
300	-4.42963E-01	-3.91219E-01	-3.22934E-01	-2.57165E-01	-1.95636E-01	-1.39611E-01	-8.97651E-02	-5.64843E-02	-4.04196E-02
315	-3.62894E-01	-3.18594E-01	-2.61195E-01	-2.06864E-01	-1.56463E-01	-1.10824E-01	-7.06362E-02	-4.42083E-02	-3.15861E-02
330	-2.57056E-01	-2.23461E-01	-1.80737E-01	-1.41253E-01	-1.05488E-01	-7.38022E-02	-4.65122E-02	-2.90721E-02	-2.08221E-02
345	-1.31692E-01	-1.12051E-01	-8.78673E-02	-6.62562E-02	-4.72598E-02	-3.12004E-02	-1.85135E-02	-1.13778E-02	-8.19064E-03
AMPL	5.18478E-01	4.58421E-01	3.79507E-01	3.04675E-01	2.32740E-01	1.65386E-01	1.04826E-01	6.53090E-02	4.66022E-02
STDY	-3.20188E 00	-2.88795E 00	-2.47074E 00	-2.06049E 00	-1.66230E 00	-1.28045E 00	-9.19792E-01	-6.67156E-01	-5.39872E-01

PSI	STA 11	12	13	14	15	16	17
0	3.14450E-03	8.60[illegible]09E-04	5.35767E-05	6.69752E-06	3.22808E-08	-9.229[illegible]9E 18	-4.91971E 28
15	1.12702E-02	3.53860E-03	4.87709E-04	5.55291E-05	6.62802E-08	-1.56632E 55	-4.11110E 28
30	1.82196E-02	5.76355E-03	8.27214E-04	9.33242E-05	8.69113E-08	2.21511E 55	-2.12327E 28
45	2.38886E-02	7.60688E-03	1.12625E-03	1.26625E-04	1.03055E-07	-1.56632E 55	1.16114E 26
60	2.75766E-02	8.88013E-03	1.38251E-03	1.55152E-04	1.14461E-07	-4.17215E 49	1.24257E 28
75	2.83228E-02	9.23049E-03	1.52551E-03	1.70715E-04	1.14544E-07	1.56632E 55	1.10925E 28
90	2.61158E-02	8.64994E-03	1.54541E-03	1.72365E-04	1.02175E-07	-2.21511E 55	1.28688E 25
105	2.14997E-02	7.24598E-03	1.41878E-03	1.57300E-04	7.61295E-08	1.56630E 55	-1.11148E 28
120	1.63277E-02	5.65285E-03	1.24039E-03	1.36646E-04	4.84163E-08	1.67943E 50	-1.24128E 28
135	1.16944E-02	4.20208E-03	1.04293E-03	1.14244E-04	2.81597E-08	-1.56634E 55	-1.16165E 26
150	7.70494E-03	2.93644E-03	8.34120E-04	9.11847E-05	1.88181E-08	2.21511E 55	2.12198E 28
165	3.10251E-03	1.41765E-03	5.46002E-04	5.94945E-05	9.02736E-09	-1.56629E 55	4.11333E 28
180	-2.78574E-03	-6.05481E-04	1.35775E-04	1.39412E-05	-1.15720E-08	-2.51914E 50	4.91714E 28
195	-8.34322E-03	-2.54346E-03	-2.89222E-04	-3.30201E-05	-3.15053E-08	1.56633E 55	4.11333E 28
210	-1.26652E-02	-4.07399E-03	-6.63661E-04	-7.40580E-05	-4.39435E-08	-2.21511E 55	2.12199E 28
225	-1.61261E-02	-5.25232E-03	-9.44147E-04	-1.04414E-04	-5.31716E-08	1.56631E 55	-1.16076E 26
240	-2.01032E-02	-6.61047E-03	-1.23130E-03	-1.36142E-04	-7.24797E-08	3.35885E 50	-1.24128E 28
255	-2.41575E-02	-8.01349E-03	-1.51284E-03	-1.67749E-04	-9.84193E-08	-1.56633E 55	-1.11148E 28
270	-2.68118E-02	-8.97205E-03	-1.70959E-03	-1.90063E-04	-1.18182E-07	2.21511E 55	1.28302E 25
285	-2.72289E-02	-9.20747E-03	-1.76974E-03	-1.97330E-04	-1.25099E-07	-1.56630E 55	1.10925E 28
300	-2.41842E-02	-8.17806E-03	-1.56603E-03	-1.74545E-04	-1.09632E-07	-4.19857E 50	1.24257E 28
315	-1.89012E-02	-6.41286E-03	-1.23808E-03	-1.37940E-04	-8.13072E-08	1.56634E 55	1.16406E 26
330	-1.25389E-02	-4.31175E-03	-8.48416E-04	-9.45027E-05	-4.72535E-08	-2.21511E 55	-2.12324E 28
345	-5.02120E-03	-1.81206E-03	-3.93156E-04	-4.34536E-05	-7.69389E-09	1.56630E 55	-4.11109E 28
AMPL	2.77759E-02	9.21898E-03	1.65757E-03	1.84848E-04	1.19822E-07	2.21511E 55	4.91842E 28
STDY	-4.04543E-01	-2.46215E-01	-1.30883E-01	-4.33228E-02	-8.38682E-04	2.69029E 19	3.16495E-57

Similar output for Z, THETA, BETA, ZETA,

COMPREHENSIVE ROTOR ANALYSIS
ROTATING HUB LOADS AND CONTROL FORCES

ROTATING HUB LOADS AT ROTOR CENTER FOR 4 BLADES

K	F XR LB	F YR LB	F ZR LB	M XR LB-IN	M YR LB-IN	M ZR LB-IN
0			7.0181E 04			-1.6799E 06
1C	1.1305E 04	-1.0659E 04		1.2079E 06	1.2415E 06	
1S	-1.0659E 04	-1.1305E 04		1.2415E 06	-1.2079E 06	
1	1.5538E 04	1.5538E 04		1.7321E 06	1.7321E 06	
2C						
2S						
2						
3C	-2.6621E 03	1.5988E 03		2.0452E 04	2.1156E 05	
3S	-1.5988E 03	-2.6621E 03		-2.1156E 05	2.0452E 04	
3	3.1053E 03	3.1053E 03		2.1255E 05	2.1255E 05	
4C			-1.3894E 03			-5.4678E 04
4S			-6.6245E 03			-8.8428E 04
4			6.7687E 03			1.0397E 05
5C	-1.7187E 03	1.8225E 03		5.1657E 04	-2.7596E 04	
5S	1.8225E 03	1.7187E 03		-2.7596E 04	-5.1657E 04	
5	2.5050E 03	2.5050E 03		5.8566E 04	5.8566E 04	
6C						
6S						
6						
7C	4.7186E 02	1.0461E 02		-2.9836E 02	1.6766E 04	
7S	-1.0461E 02	4.7186E 02		-1.6766E 04	-2.9836E 02	
7	4.8331E 02	4.8331E 02		1.6768E 04	1.6768E 04	
8C			4.5912E 02			-5.2784E 03
8S			-7.8547E 02			-2.6281E 03
8			9.0981E 02			5.8965E 03
9C	-5.4649E 01	-3.3680E 02		2.9461E 04	3.3339E 04	
9S	-3.3680E 02	5.4649E 01		3.3339E 04	-2.9461E 04	
9	3.4121E 02	3.4121E 02		4.4491E 04	4.4491E 04	
10C						
10S						
10						

FIXED HUB LOADS AT ROTOR CENTER FOR 4 BLADES

K	F XF LB	F YF LB	F ZF LB	M XF LB-IN	M YF LB-IN	M ZF LB-IN
0	1.1305E 04	-1.0659E 04	7.0181E 04	1.2079E 06	1.2415E 06	-1.6799E 06
4C	-4.3808E 03	3.4213E 03	-1.3894E 03	7.2109E 04	1.8397E 05	-5.4678E 04
4S	2.2366E 02	-9.4345E 02	-6.6245E 03	-2.3916E 05	-3.1205E 04	-8.8428E 04
4	4.3865E 03	3.5490E 03	6.7687E 03	2.4980E 05	1.8660E 05	1.0397E 05
8C	4.1721E 02	-2.3219E 02	4.5912E 02	2.9163E 04	5.0105E 04	-5.2784E 03
8S	-4.4141E 02	5.2650E 02	-7.8547E 02	1.6573E 04	-2.9760E 04	-2.6281E 03
8	6.0738E 02	5.7543E 02	9.0981E 02	3.3543E 04	5.8276E 04	5.8965E 03

COMPREHENSIVE ROTOR ANALYSIS
ROTATING HUB LOADS AND CONTROL FORCES
STEADY LOADS RELATIVE TO FORWARD VELOCITY

K	FXF A LB	FYF A LB	FZF A LB	MXF A LB-IN	MYF A LB-IN	MZF A LB-IN
0	-1.4379E 03	-1.0659E 04	7.1071E 04	1.4890E 06	1.2415E 06	-1.4366E 06

RHP = 4.1580E 03

HARMONIC CONTROL FORCES

K	F LB	P1 LB	P2 LB	P3 LB
0	2.4258E 03	-3.7483E 03	-8.7588E 03	2.8040E 03
1C	-1.8558E 03			
1S	2.6575E 03			
1	3.2414E 03			
2C	-1.4970E 03			
2S	-8.6439E 02			
2	1.7287E 03			
3C	-6.6785E 02			
3S	-2.0879E 02			
3	6.9973E 02			
4C	4.3542E 01	1.8178E 01	-1.1262E 03	9.3390E 02
4S	-1.1638E 03	2.6179E 03	2.5153E 03	-4.7811E 02
4	1.1646E 03	2.6180E 03	2.7560E 03	1.0492E 03
5C	2.2244E 02			
5S	2.4331E 02			
5	3.2967E 02			
6C	-3.7559E 02			
6S	9.1523E 01			
6	3.8658E 02			
7C	4.9693E 01			
7S	8.2638E 01			
7	9.6429E 01			
8C	7.5911E 01	2.8551E 02	-4.6072E 01	-5.4309E 02
8S	1.0113E 02	-2.5523E 02	-3.4316E 02	1.9389E 02
8	1.2645E 02	3.8257E 02	3.4624E 02	5.7666E 02
9C	-9.8101E 01			
9S	-1.3063E 02			
9	1.6336E 02			
10C	8.9840E 01			
10S	4.1793E 01			
10	9.9085E 01			

COMPREHENSIVE ROTOR ANALYSIS
ROTATING HUB LOADS AND CONTROL FORCES

VIBRATORY CONTROL FORCES

PSI DEG	F LB	P1 LB	P2 LB	P3 LB
0	-4.0130E 03	3.0369E 02	-1.1723E 03	3.9081E 02
15	-4.0186E 03	1.9125E 03	1.3411E 03	4.9235E 02
30	-2.7799E 03	2.3364E 03	3.0617E 03	-7.7738E 02
45	-5.0463E 02	2.6734E 02	1.0802E 03	-1.4770E 03
60	2.7154E 03	-2.6401E 03	-1.8894E 03	3.8657E 02
75	4.9393E 03	-2.1758E 03	-2.4212E 03	9.8464E 02
90	4.7985E 03	3.0369E 02	-1.1723E 03	3.9081E 02
105	3.5595E 03	1.9125E 03	1.3411E 03	4.9235E 02
120	2.1458E 03	2.3364E 03	3.0617E 03	-7.7738E 02
135	3.3867E 03	2.6734E 02	1.0802E 03	-1.4770E 03
150	4.6663E 03	-2.6401E 03	-1.8894E 03	3.8656E 02
165	2.7630E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
180	6.8631E 02	3.0369E 02	-1.1723E 03	3.9081E 02
195	-1.2424E 03	1.9125E 03	1.3411E 03	4.9235E 02
210	-1.7560E 03	2.3364E 03	3.0617E 03	-7.7737E 02
225	-1.2589E 03	2.6735E 02	1.0802E 03	-1.4770E 03
240	-1.5575E 03	-2.6401E 03	-1.8894E 03	3.8656E 02
255	-1.0221E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
270	-9.9410E 02	3.0368E 02	-1.1723E 03	3.9081E 02
285	-2.0443E 03	1.9125E 03	1.3411E 03	4.9235E 02
300	-2.2306E 03	2.3364E 03	3.0617E 03	-7.7737E 02
315	-1.4937E 03	2.6738E 02	1.0802E 03	-1.4770E 03
330	-1.6813E 03	-2.6400E 03	-1.8894E 03	3.8655E 02
345	-3.0638E 03	-2.1758E 03	-2.4213E 03	9.8464E 02
MAX POS	4.9393E 03	2.3364E 03	3.0617E 03	9.8464E 02
MAX NEG	-4.0186E 03	-2.6401E 03	-2.4213E 03	-1.4770E 03
AMPLTD	4.4789E 03	2.4882E 03	2.7415E 03	1.2308E 03

TS	RHP	X	L	L/DE
7.39287E 04	4.15757E 03	2.10873E 03	7.47583E 04	1.17656E 01

X/L	L/QD2SIG	X/QD2SIG	P/QD2SIGV	CT/SIG
2.82072E-02	1.24151E 00	3.50197E-02	1.40541E-01	1.01072E-01

CTP/SIG	CH/SIG	CP/SIG	CY/SIG
1.02207E-01	1.54559E-02	4.16056E-03	-1.45724E-02

23010AIFFOILCONST. SECT,38IN CHORD,46FTRADIUS,9DEG TWIST,CASE 44-1 PAGE E4

VIB PITCH LINK LOADS FOR EACH ITERATION.-LBS (POSITIVE IN COMPRESSION)

	ITER 0	ITER 1	ITER 2	ITER 3	ITER 4	ITER 5	ITER 6	ITER 7	ITER 8	ITER 9	ITER 10
0	-7.208E 03	-5.096E 03	-4.765E 03	-5.292E 03	-5.434E 03	-5.866E 03	-5.116E 03	-4.853E 03	-4.255E 03	-3.662E 03	-4.013E 03
15	-5.968E 03	7.835E 02	-5.959E 03	-6.463E 03	-6.732E 03	-7.851E 03	-5.775E 03	-4.898E 03	-4.674E 03	-4.284E 03	-4.019E 03
30	-6.468E 03	1.117E 04	-2.926E 03	-5.431E 03	-5.759E 03	-5.423E 03	-3.992E 03	-3.356E 03	-3.168E 03	-2.784E 03	-2.780E 03
45	-6.025E 03	1.809E 04	-8.238E 02	-9.989E 02	-1.834E 03	-2.282E 03	-2.045E 02	-9.083E 02	-2.654E 02	-4.480E 02	-5.046E 02
60	-1.461E 03	1.778E 04	1.645E 03	3.119E 03	1.958E 03	1.379E 03	3.359E 03	2.653E 03	2.782E 03	2.523E 03	2.715E 03
75	1.258E 04	1.395E 04	2.278E 03	5.452E 03	5.028E 03	6.145E 03	6.988E 03	3.777E 03	4.568E 03	4.997E 03	4.939E 03
90	2.585E 04	6.819E 03	1.143E 03	9.255E 03	6.056E 03	6.070E 03	7.212E 03	3.508E 03	4.701E 03	4.938E 03	4.799E 03
105	3.038E 04	3.394E 03	7.744E 03	1.057E 04	4.950E 03	6.592E 03	5.193E 03	2.614E 03	5.208E 03	4.623E 03	3.559E 03
120	2.861E 04	1.633E 03	1.355E 04	1.156E 04	1.763E 03	1.104E 04	4.901E 03	2.643E 03	8.055E 03	3.695E 03	2.146E 03
135	2.114E 04	-4.175E 03	1.730E 04	8.272E 03	2.499E 03	1.549E 04	4.668E 03	3.798E 03	5.964E 03	2.339E 03	3.387E 03
150	1.185E 04	-4.785E 03	1.505E 04	4.421E 02	9.344E 03	1.271E 04	3.342E 03	3.828E 03	1.456E 03	2.538E 03	4.666E 03
165	-6.458E 02	-2.196E 03	4.256E 03	-2.420E 03	1.279E 04	3.345E 03	1.321E 03	4.764E 03	1.415E 03	2.135E 03	2.763E 03
180	-1.356E 04	5.529E 02	-7.309E 02	-3.139E 03	1.095E 04	-1.310E 03	3.659E 02	4.307E 03	5.389E 02	8.094E 02	6.863E 02
195	-1.848E 04	4.305E 03	-2.372E 03	-3.173E 02	6.638E 03	-3.828E 03	4.646E 02	1.835E 03	-7.685E 02	-7.349E 02	-1.242E 03
210	-1.668E 04	-9.549E 02	-5.190E 03	1.653E 03	7.094E 02	-6.601E 03	9.710E 01	-3.261E 02	-2.071E 03	-2.051E 03	-1.756E 03
225	-1.131E 04	-9.353E 03	-8.321E 03	-1.919E 03	-6.231E 03	-7.794E 03	-1.555E 03	-2.528E 03	-3.603E 03	-2.466E 03	-1.259E 03
240	-6.122E 03	-1.015E 04	-9.140E 03	-4.559E 03	-1.031E 04	-8.147E 03	-4.055E 03	-3.013E 03	-3.406E 03	-2.506E 03	-1.557E 03
255	-3.094E 03	-6.709E 03	-5.084E 03	-4.528E 03	-8.512E 03	-4.651E 03	-3.799E 03	-1.253E 03	-1.786E 03	-1.139E 03	-1.022E 03
270	-7.896E 02	-3.581E 03	-2.019E 03	-1.624E 03	-4.744E 03	-6.929E 02	-1.548E 03	-2.287E 02	-5.566E 02	-1.343E 02	-9.941E 02
285	-6.480E 02	-4.219E 03	-2.119E 03	-9.335E 02	-1.851E 03	-6.160E 02	-1.169E 03	-1.852E 03	-2.447E 03	-1.602E 03	-2.044E 03
300	-3.636E 03	-5.115E 03	-2.978E 03	-2.349E 03	-2.312E 03	-2.056E 03	-1.962E 03	-2.680E 03	-2.588E 03	-2.056E 03	-2.231E 03
315	-7.452E 03	-5.208E 03	-2.608E 03	-2.885E 03	-3.073E 03	-1.359E 03	-2.044E 03	-2.266E 03	-8.886E 02	-9.474E 02	-1.494E 03
330	-1.039E 04	-8.269E 03	-3.643E 03	-3.634E 03	-2.221E 03	-1.104E 03	-2.603E 03	-2.483E 03	-1.528E 03	-1.309E 03	-1.681E 03
345	-1.047E 04	-8.580E 03	-4.288E 03	-3.832E 03	-3.673E 03	-3.189E 03	-4.087E 03	-3.082E 03	-2.721E 03	-2.473E 03	-3.064E 03
AMPL	2.443E 04	1.412E 04	1.322E 04	9.011E 03	1.155E 04	1.182E 04	6.494E 03	4.831E 03	6.365E 03	4.641E 03	4.479E 03
STDY	6.034E 03	7.159E 03	4.636E 03	3.329E 03	4.118E 03	3.704E 03	3.082E 03	3.185E 03	2.647E 03	2.296E 03	2.426E 03

VIBRATORY PITCH LINK LOADS EVERY 5 DEGREES FOR THE LAST ITERATION ONLY

PSI		PSI		PSI		PSI		PSI		PSI		PSI		PSI	
0	-4.013E 03	45	-5.046E 02	90	4.799E 03	135	3.387E 03	180	6.863E 02	225	-1.259E 03	270	-9.941E 02	315	-1.494E 03
5	-4.134E 03	50	4.960E 02	95	4.482E 03	140	4.130E 03	185	3.738E 01	230	-1.336E 03	275	-1.322E 03	320	-1.368E 03
10	-4.143E 03	55	1.598E 03	100	4.072E 03	145	4.615E 03	190	-6.318E 02	235	-1.477E 03	280	-1.705E 03	325	-1.426E 03
15	-4.019E 03	60	2.715E 03	105	3.559E 03	150	4.666E 03	195	-1.242E 03	240	-1.557E 03	285	-2.044E 03	330	-1.681E 03
20	-3.745E 03	65	3.720E 03	110	2.981E 03	155	4.273E 03	200	-1.674E 03	245	-1.492E 03	290	-2.264E 03	335	-2.093E 03
25	-3.325E 03	70	4.485E 03	115	2.453E 03	160	3.572E 03	205	-1.841E 03	250	-1.284E 03	295	-2.326E 03	340	-2.582E 03
30	-2.780E 03	75	4.939E 03	120	2.146E 03	165	2.763E 03	210	-1.756E 03	255	-1.022E 03	300	-2.231E 03	345	-3.064E 03
35	-2.129E 03	80	5.093E 03	125	2.204E 03	170	1.997E 03	215	-1.533E 03	260	-8.334E 02	305	-2.013E 03	350	-3.476E 03
40	-1.376E 03	85	5.018E 03	130	2.461E 03	175	1.319E 03	220	-1.329E 03	265	-8.152E 02	310	-1.738E 03	355	-3.794E 03

C O N V E R G E N C E   S U M M A R Y

ITER	CCLLECTIVE X/R=0.800	THRUST	ANGLE OF ATTACK STA 4 X/R=,0.800 PSI=0	PSI=90	PSI=180	PSI=270	Z TIP AMPL	THETA TIP AMPL	ROOT FBM AMPL
0	6.775	72664.00	-0.685	13.213	3.646	-12.867	47.533	16.772	175262.69
1	12.276	72667.31	17.795	-2.771	13.568	-6.280	71.115	10.815	101255.38
2	8.221	72707.50	4.672	3.710	2.144	1.710	96.355	15.110	94805.69
3	8.320	72665.00	5.853	5.829	11.995	3.8C8	110.592	11.525	64646.97
4	9.132	72684.13	5.106	-3.511	14.025	9.976	96.759	14.605	82844.13
5	8.636	72703.69	3.959	3.091	2.532	2.739	94.586	14.874	84806.31
6	8.499	72687.56	6.875	1.818	11.612	4.429	101.897	10.408	46580.78
7	8.058	72721.94	4.719	0.106	7.695	7.780	99.989	11.738	34666.78
8	7.178	72661.19	5.103	3.551	2.206	9.563	97.537	9.963	45664.91
9	7.532	72662.75	6.041	1.642	7.649	6.8C8	97.764	10.181	33261.38
10	7.333	72731.00	5.109	0.472	5.280	7.172	90.432	10.418	32123.22

SAMPLE BLADE PROPERTY IDEALIZATION PROGRAM INPUT AND OUTPUT

The Blade Property Idealization Program converts the continuous blade property distributions into a system of discrete point masses connected by massless elastic elements. The blade properties considered are blade mass, chordwise centroid, polar mass moment of inertia, flapwise flexural stiffness, chordwise flexural stiffness, and torsional rigidity.

A sample input and output are presented. This output was used to obtain the input for the sample C-70 program. Also presented are the distributed blade property curves.(Figures 25 through 32) which provided the input data.

Complete sheets 1, 1A, 2, 3, 4, and 5.

1. Basic Control Sheet - Locs 1 through 30.

LOC	DEF	DIM.	DESCRIPTION
01	Prog	-	Not used. Set equal to 1
02	Flap Bdry	-	Not used. Set equal to 1
03	Lag Bdry	-	Not used. Set equal to 1
04	R	ft	Blade radius
05	C_o	in.	Blade constant chord
06	e_o	in.	Not used. Set equal to 0
07	b	in.	Not used. Set equal to 1
08	K_Z	lb/in.	Not used. Set equal to 0
09	K_θ	$\frac{\text{lb-in.}}{\text{rad}}$	Not used. Set equal to 0
10	Ω	rpm	Not used. Set equal to 1
11	ω_s	HZ	Not used. Set equal to 0

LOC	DEF	DIM.	DESCRIPTION
12	ω_f	Hz	Not used. Set equal to 1
13	$\Delta\omega$	Hz	Not used. Set equal to 1
14	n	-	Number of mass stations
15	Inp	-	Set equal to 1
16	D.O.F.	-	Not used. Set equal to 1
17	n_B	-	Total number of blade masses
18	E	-	Not used. Set equal to 0
19	K_ξ	lb-in./rad	Not used. Set equal to 0
20	e_β	in.	Flap hinge offset
21	e_ξ	in.	Lag hinge offset
22	C_ξ	$\frac{\text{lb-sec}}{\text{in.}}$	Not used. Set equal to 0
23	I_F	chug in.^{2}	Not used. Set equal to 1
24	I_L	chug in.^{2}	Not used. Set equal to 1
25	BL	-	Not used. Set equal to 1
26	M_{H_β}	chugs	Not used. Set equal to 0
27	M_{H_L}	chugs	Not used. Set equal to 0
28	K_β	$\frac{\text{in.lb}}{\text{rad}}$	Not used. Set equal to 0
29	C_β	chugs/sec	Not used. Set equal to 0

2. Subroutine WICK Input Description - Locs 100-1000

LOC	DEF	DIM.	DESCRIPTION
100	Wick	-	Control for use of subroutine WICK. Set equal to 0
101	M	chugs	Mass at bay centers Set equal to 1
102	$\overline{M}$	chugs	Cabled mass Set equal to 0
103	I	chug-in.^{2}	Pitch inertia Set equal to 1
104	Y	in.	Distance from pitch axis to bay mass center Set equal to 1
105	Blank	-	Not used. Set equal to 0
106	EI_β	lb-in.^{2}	Flapwise flexural rigidity Set equal to 1
107	EI_ξ	lb.-in.^{2}	Lagwise flexural rigidity Set equal to 1
108	GJ	lb-in.	Torsional rigidity of bay Set equal to 1
109	EA	lb	Elastic axis rigidity Set equal to 0
110	-	-	Use for numbering cases Set equal to 1
111	R	in.	Blade radius
112-161	r or r/R	in. or N.D.	Blade boundary locations NOTE: These blade boundaries must correspond to those used in C-70 Locs 290-315. Therefore, last boundary is flap hinge location and must be in inches; i.e., same as Locs 20, 171, 371, 471, 581, 681, and 901. The next to the last boundary is lag hinge location and must be in inches; i.e., same as Locs 21 and 791.

LOC	DEF	DIM.	DESCRIPTION
162	e_ξ	in.	Lag hinge location
170	-	-	Use for numbering cases Set equal to 1
171	e_β	in.	Flap hinge location
172-269	r or r/R	in. or N.D.	Blade boundary locations
271-369	ω	lb/in.	Running weight
370	-	-	Cabled weight case Use for numbering cases Set equal to 1
371	e_β	in.	Flap hinge location Set equal to zero if not using cabled weight
372-419	r or r/R	in. or N.D.	Blade boundary locations
421-469	$\bar{\omega}$	lb/in.	Running cabled weight
470	-	-	Pitch inertia case Using for numbering cases Set equal to 1
471	e_β	in.	Flap hinge location
472-519	r or r/R	in. or N.D.	Blade boundary locations
521-569	$I_p \times 10^2$	lb-sec^2-in.	Running pitch inertia
571	-	-	Chordwise centroid case Use for numbering cases Set equal to 1
572	C_o	in.	Blade constant chord
573	-	in.	Pitch axis offset (aft of L.E.)
581	e_β	in.	Flap hinge location
582-629	r or r/R	in. or N.D.	Blade boundary locations
631-679	$\bar{\gamma}$	in.	Mass offset from leading edge
680	-	-	Flap EI case Use for numbering cases Set equal to 1

LOC	DEF	DIM.	DESCRIPTION
681	e_β	in.	Flap hinge location
682-730	r or r/R	in. or N.D.	Blade boundary locations
731-780	EI_β X 10^{-6}	lb-in.^{2}	Flap rigidity (running)
790	-	-	Lag EI case Use for numbering cases Set equal to 1
791	e_ξ	in.	Lag hinge location
792-840	r or r/R	in. or N.D.	Blade boundary locations
841-890	EI_ξ X 10^{-6}	lb-in.^{2}	Lag rigidity (running)
900	-	-	Torsional rigidity case Use for numbering cases Set equal to 1
901	e_β	in.	Flap hinge location
902-950	r or r/R	in. or N.D.	Blade boundary locations
951-1000	GJ X 10^{-6}	lb-in.^{2}	Torsional rigidity (running)

NOTE: Input 9999999. in the location immediately following the last entry in each group of input data. See sample input sheet. Distributed properties are input beginning at the inboard end of the blade.

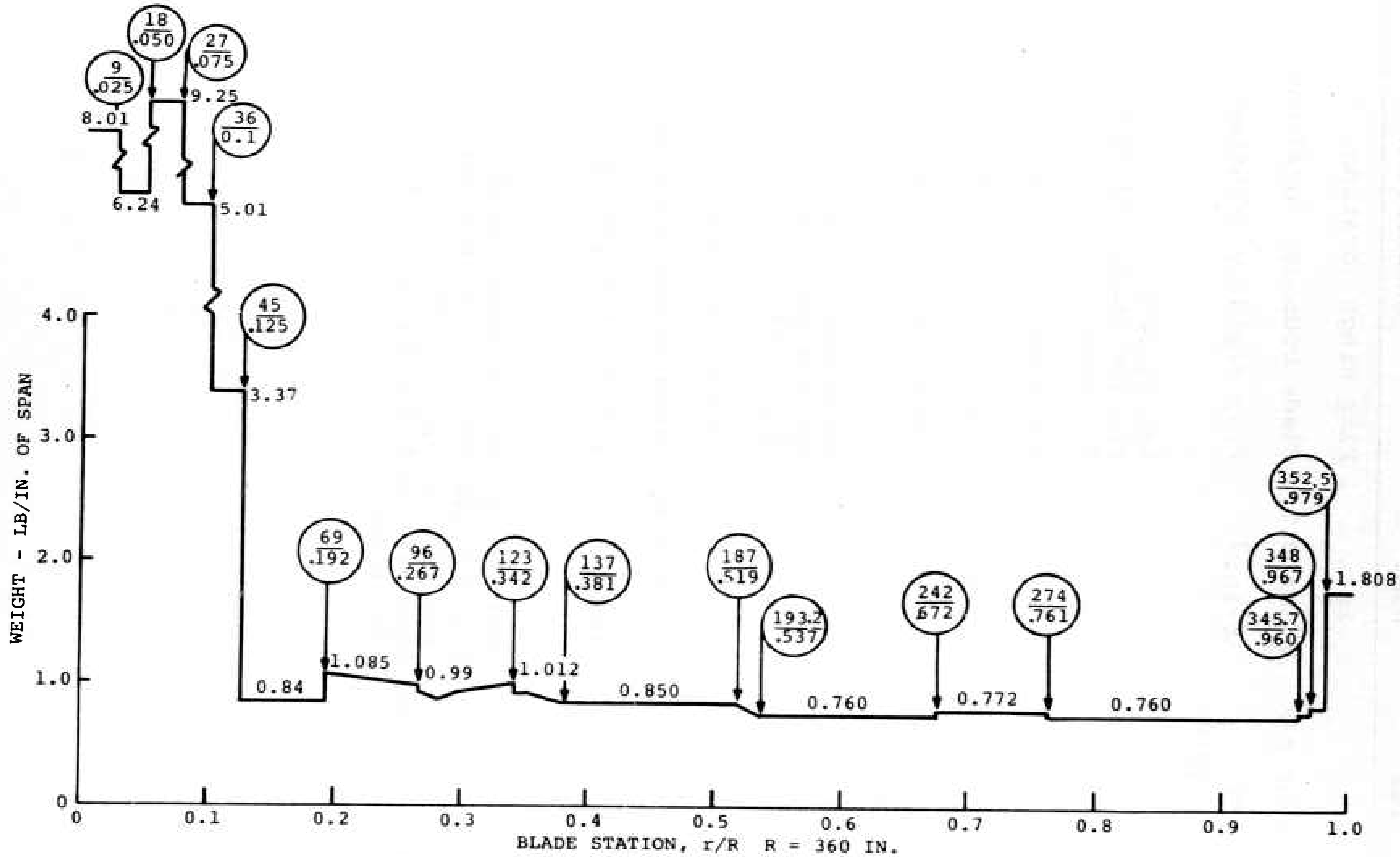

Figure 25. Spanwise Weight Distribution of CH-47 Rotor Blade

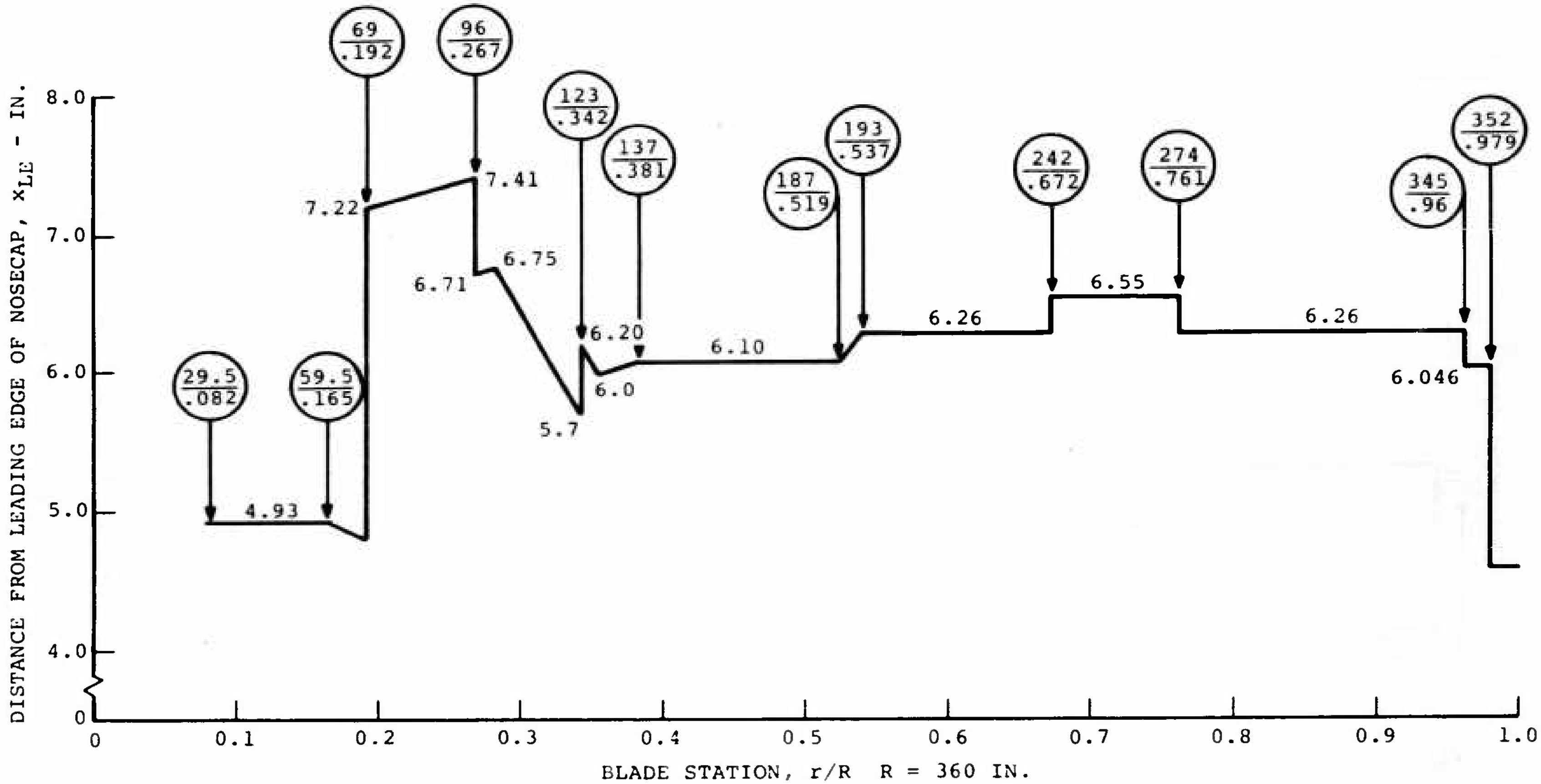

Figure 26. Effective Centroidal Axis Location of CH-47 Rotor Blade

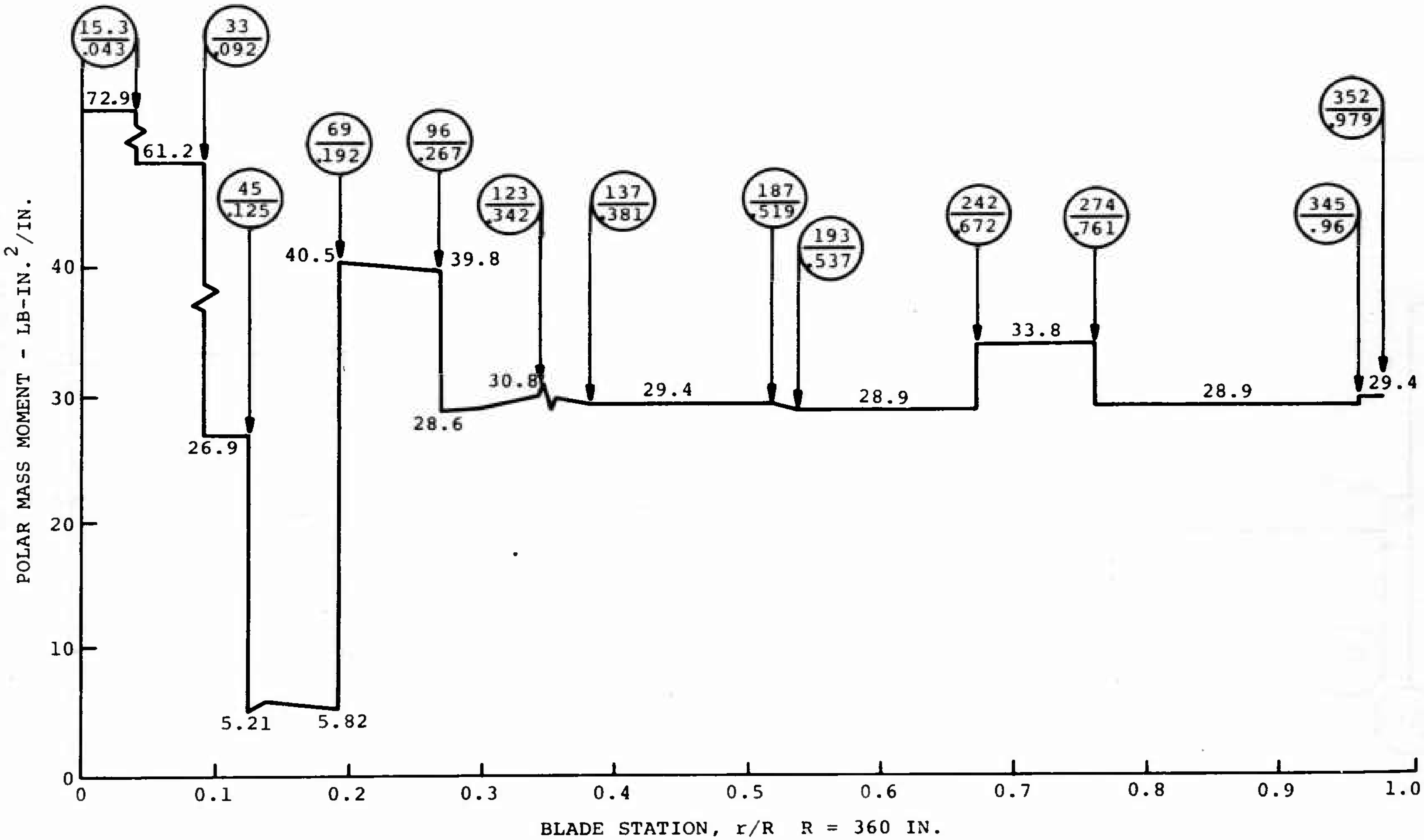

Figure 27. Effective Polar Mass Moment of Inertia About Pitch Axis of CH-47 Rotor Blade

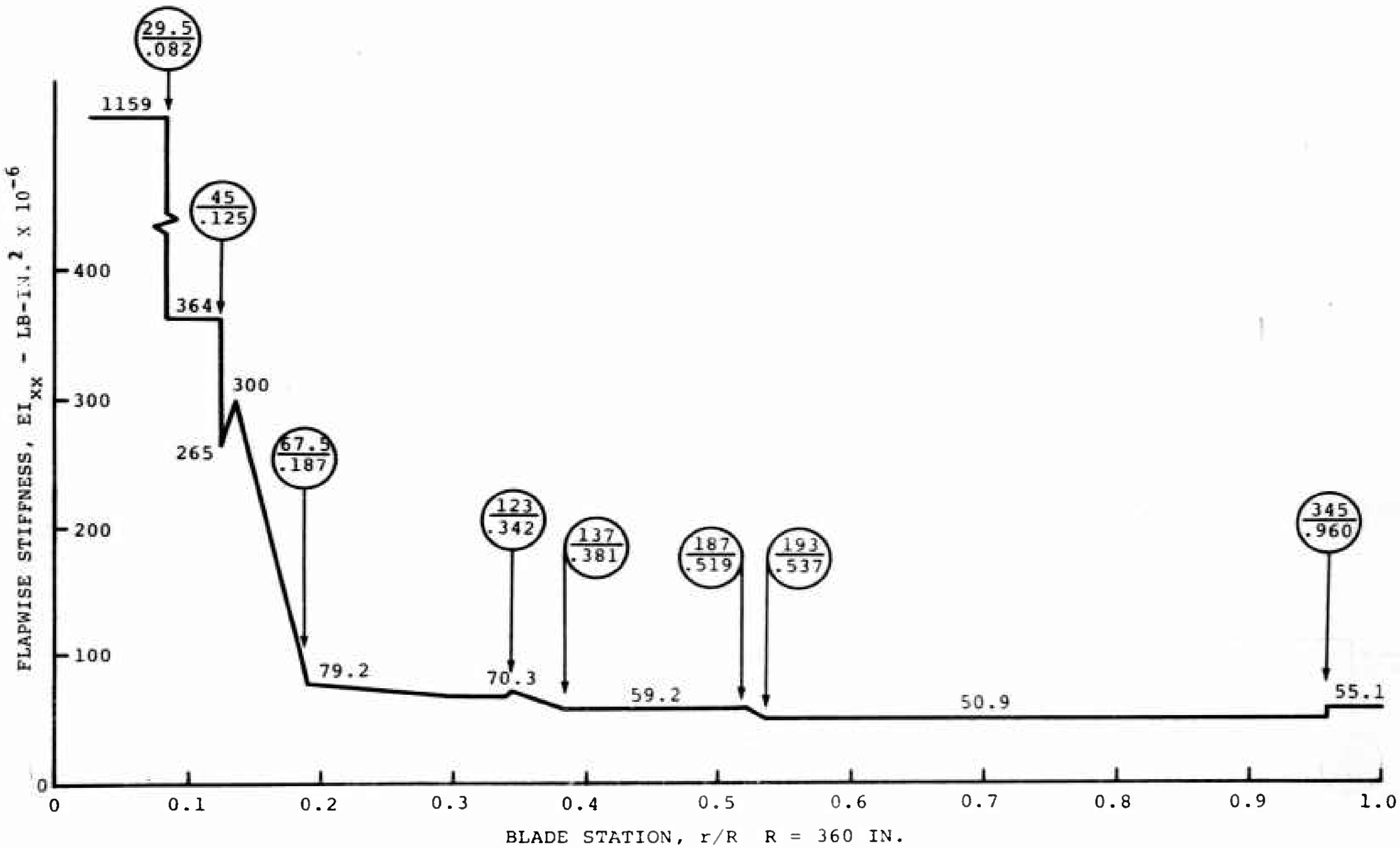

Figure 28. Effective Flapwise Stiffness Distribution of CH-47 Rotor Blade

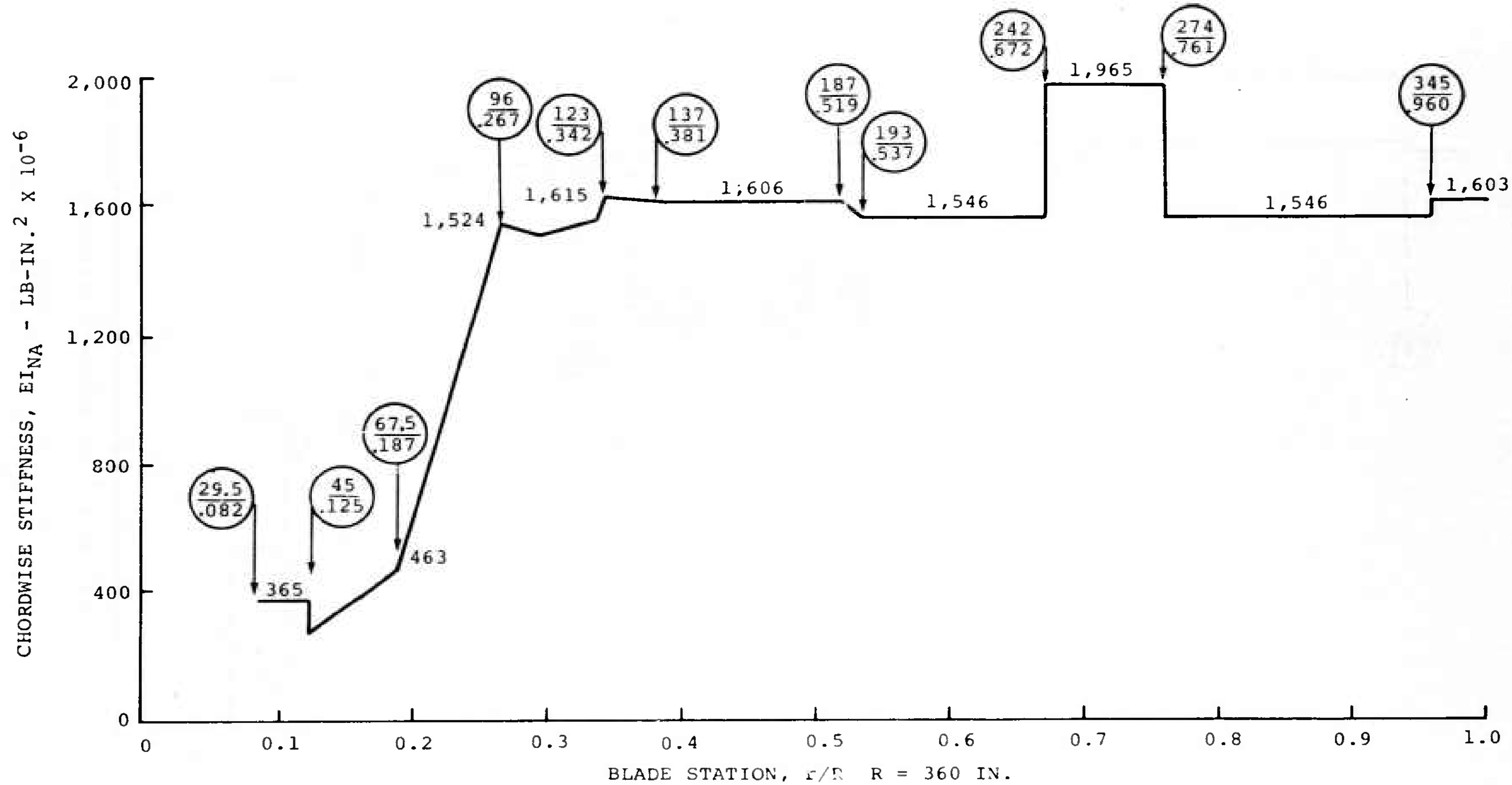

Figure 29. Effective Chordwise Stiffness Distribution of CH-47 Rotor Blade

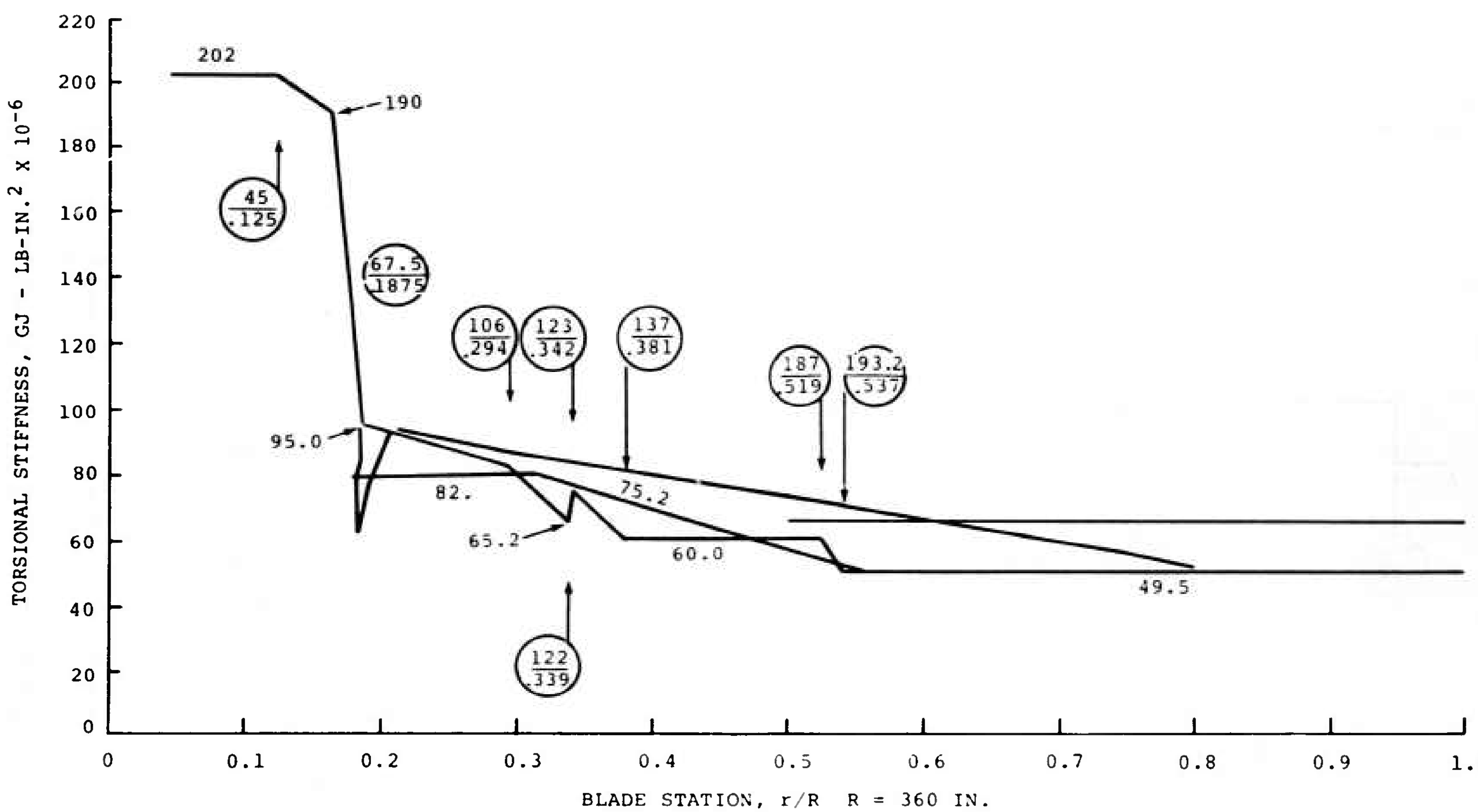

Figure 30. Torsional Stiffness Distribution of CH-47 Rotor Blade

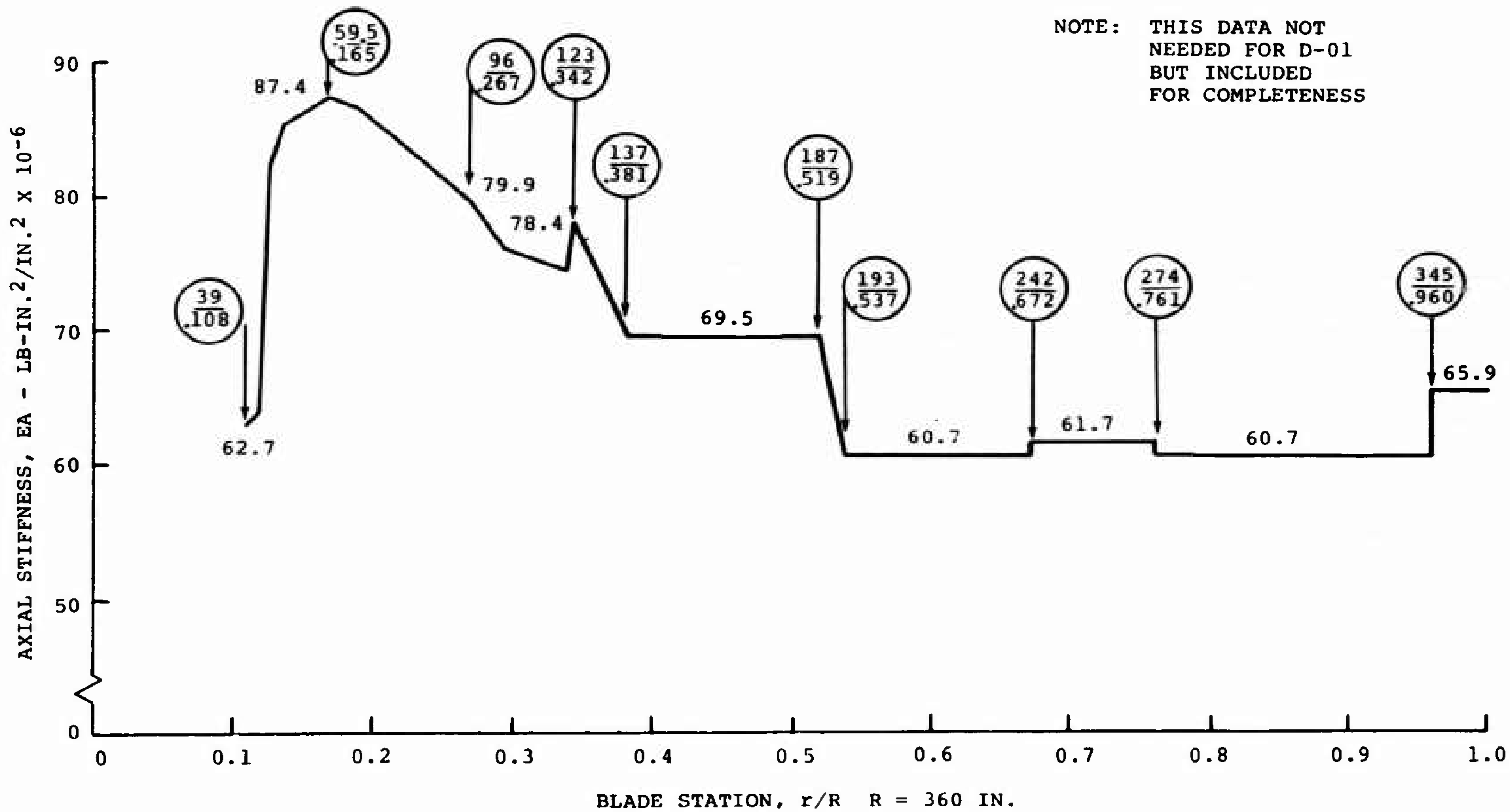

Figure 31. Effective Axial Stiffness Distribution of CH-47 Rotor Blade

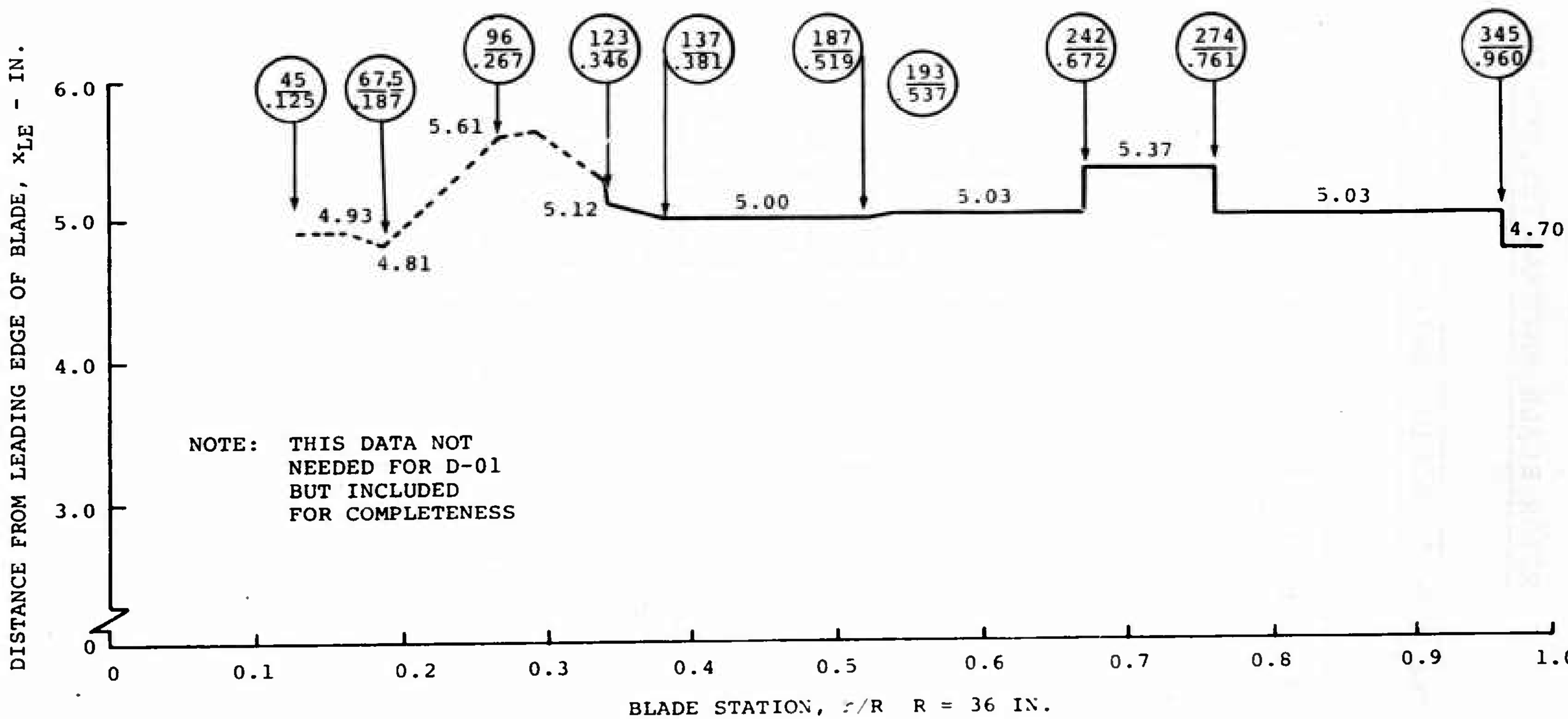

Figure 32. Effective Neutral Axis Location of CH-47 Rotor Blade

PROGRAM D-01

ROTOR BLADE NATURAL FREQUENCIES

TITLE CH-47C SOLID TRAILING EDGE

DEF	DIM.	LOC	VALUE	DEF	DIM.	LOC	VALUE
Prog.	-	01	1.	D.O.F.	-	16	1.
Flap Bdry	-	02	1.	n_B	-	17	10.
Lag Bdry	-	03	1.	ϵ	-	18	0.
R	ft	04	30.	K_ξ	$\frac{Lb}{In.}$	19	0.
c_o	in.	05	25.25	e_β	In.	20	8.
e_o	in.	06	1.58	e_ξ	In.	21	29.5
b	in.	07	10.25	C_ξ	$\frac{Chug.}{Sec}$	22	70,000.
K_z	$\frac{lb}{in.}$	08	11,850.	I_F	$Ch.In^2$	23	0.
K_θ	$\frac{lb\text{-}in.}{rad}$	09	0.	I_L	$Ch.In^2$	24	0.
Ω	rpm	10	230.	BL	-	25	3.
ω_s	Hz	11	0.	M_{H_β}	Chug	26	0.
ω_f	Hz	12	49.8	M_{H_L}	Chug	27	0.
$\Delta\omega$	Hz	13	0.2			28	0.
n	-	14	15.			29	0.
Inp	-	15	1.			30	0.

SHEET 1A

PROGRAM D-01 - SUBROUTINE WICK
BLADE PROPERTIES DISTRIBUTION

Required Distribution

Control		0	100	0.
Blade Weight.	m	1	101	1.
Cabled Weight.	Δm	2	102	0.
Pitch Inertia.	I	3	103	1.
Chordwise Centroid.	y	4	104	1.
		5	105	0.
Flap EI	EI_{β}	6	106	1.
Lag EI	EI_{ζ}	7	107	1.
Torsion GJ.	GJ	8	108	1.
Elastic Axis.	EA	9	109	0.

	Loc.	
Boundary Case No.	110	1.

Boundary	Loc	r(in) or r/R
b 0.1	111	360.
b 1.2	112	0.99
b 2.3	113	0.95
b.3.4	114	0.9
b 4.5	115	0.8
b 5.6	116	0.7
b 6.7	117	0.6
b 7.8	118	0.5
b 8.9	119	0.4
b 9.10	120	0.3
b10.11	121	0.195
b11.12	122	0.18
b12.13	123	0.16
b13.14	124	0.132
b14.15	125	29.5
b15.16	126	8.0
b16.17	127	9999999.
b17.18	128	
b18.19	129	
b19.20	130	
b20.21	131	
b21.22	132	
b22.23	133	
b23.24	134	
b24.25	135	
b25.26	136	

Boundary	Loc	r(in) or r/R
b26.27	137	
b27.28	138	
b28.29	139	
b29.30	140	
b30.31	141	
b31.32	142	
b32.33	143	
b33.34	144	
b34.35	145	
b35.36	146	
b36.37	147	
b37.38	148	
b38.39	149	
b39.40	150	
b40.41	151	
b41.42	152	
b42.43	153	
b43.44	154	
b44.45	155	
b45.46	156	
b46.47	157	
b47.48	158	
b48.49	159	
b49.50	160	
b50.51	161	

Use the same dimension at Loc. 162 as the dimension of e input at Loc. bx.y

Lag Hinge	162	29.5	ins. or N.D.

PROGRAM D01

LOC	CASE
170	1

BLADE WEIGHT

Point	Loc	r(in) or r/R	Loc	lb/in run	Point	Loc	r(in) or r/R	Loc	lb/in run
1	171	8.	271	8.01	51	221		321	
2	172	0.025	272	8.01	52	222		322	
3	173	0.025	273	6.24	53	223		323	
4	174	0.05	274	6.24	54	224		324	
5	175	0.05	275	9.25	55	225		325	
6	176	0.075	276	9.25	56	226		326	
7	177	0.075	277	5.01	57	227		327	
8	178	0.10	278	5.01	58	228		328	
9	179	0.10	279	3.37	59	229		329	
10	180	0.125	280	3.37	60	230		330	
11	181	0.125	281	0.84	61	231		331	
12	182	0.192	282	0.84	62	232		332	
13	183	0.192	283	1.085	63	233		333	
14	184	0.267	284	0.99	64	234		334	
15	185	0.267	285	0.92	65	235		335	
16	186	0.342	286	1.012	66	236		336	
17	187	0.342	287	0.90	67	237		337	
18	188	0.381	288	0.85	68	238		338	
19	189	0.519	289	0.85	69	239		339	
20	190	0.537	290	0.76	70	240		340	
21	191	0.672	291	0.76	71	241		341	
22	192	0.672	292	0.772	72	242		342	
23	193	0.761	293	0.772	73	243		343	
24	194	0.761	294	0.760	74	244		344	
25	195	0.96	295	0.760	75	245		345	
26	196	0.96	296	0.78	76	246		346	
27	197	0.967	297	0.78	77	247		347	
28	198	0.967	298	0.83	78	248		348	
29	199	0.979	299	0.83	79	249		349	
30	200	0.979	300	1.808	80	250		350	
31	201	1.0	301	1.808	81	251		351	
32	202	9999999.	302	9999999.	82	252		352	
33	203		303		83	253		353	
34	204		304		84	254		354	
35	205		305		85	255		355	
36	206		306		86	256		356	
37	207		307		87	257		357	
38	208		308		88	258		358	
39	209		309		89	259		359	
40	210		310		90	260		360	
41	211		311		91	261		361	
42	212		312		92	262		362	
43	213		313		93	263		363	
44	214		314		94	264		364	
45	215		315		95	265		365	
46	216		316		96	266		366	
47	217		317		97	267		367	
48	218		318		98	268		368	
49	219		319		99	269		369	
50	220		320						

	Loc	No.
Cabled Weight Case	370	0.

Point	Loc	r(in) or r/R	Loc	lb/in run
1	371		421	
2	372		422	
3	373		423	
4	374		424	
5	375		425	
6	376		426	
7	377		427	
8	378		428	
9	379		429	
10	380		430	
11	381		431	
12	382		432	
13	383		433	
14	384		434	
15	385		435	
16	386		436	
17	387		437	
18	388		438	
19	389		439	
20	390		440	
21	391		441	
22	392		442	
23	393		443	
24	394		444	
25	395		445	
26	396		446	
27	397		447	
28	398		448	
29	399		449	
30	400		450	
31	401		451	
32	402		452	
33	403		453	
34	404		454	
35	405		455	
36	406		456	
37	407		457	
38	408		458	
39	409		459	
40	410		460	
41	411		461	
42	412		462	
43	413		463	
44	414		464	
45	415		465	
46	416		466	
47	417		467	
48	418		468	
49	419		469	

	Loc	No.
Pitch Inertia Case No.	470	1.

Point	Loc	r(in) or r/R	Loc	$I_p \times 10^2$ lb sec^{2}in
1	471	8.0	521	18.87
2	472	0.043	522	18.87
3	473	0.043	523	15.84
4	474	0.092	524	15.84
5	475	0.092	525	6.96
6	476	0.125	526	6.96
7	477	0.125	527	1.35
8	478	0.140	528	1.553
9	479	0.192	529	1.377
10	480	0.192	530	10.48
11	481	0.267	531	10.3
12	482	0.267	532	7.4
13	483	0.342	533	7.97
14	484	0.381	534	7.61
15	485	0.519	535	7.61
16	486	0.537	536	7.48
17	487	0.672	537	7.48
18	488	0.672	538	8.75
19	489	0.761	539	8.75
20	490	0.761	540	7.48
21	491	0.96	541	7.61
22	492	0.979	542	7.61
23	493	0.979	543	11.34
24	494	1.0	544	11.34
25	495	9999999.	545	9999999.
26	496		546	
27	497		547	
28	498		548	
29	499		549	
30	500		550	
31	501		551	
32	502		552	
33	503		553	
34	504		554	
35	505		555	
36	506		556	
37	507		557	
38	508		558	
39	509		559	
40	510		560	
41	511		561	
42	512		562	
43	513		563	
44	514		564	
45	515		565	
46	516		566	
47	517		567	
48	518		568	
49	519		569	

	Loc	No.
Chordwise Centroid Case	571	1.
Blade Constant Chord	572	25.25
Pitch Axis (aft of L.E.)	573	4.924

	Loc	No.
Flap EI Case	680	1.

Point	Loc	r(in)or r/R	Loc	inches aft of L.E.
1	581	29.5	631	4.93
2	582	0.165	632	4.93
3	583	0.192	633	4.77
4	584	0.192	634	7.22
5	585	0.267	635	7.41
6	586	0.267	636	6.71
7	587	0.283	637	6.75
8	588	0.342	638	5.7
9	589	0.342	639	6.2
10	590	0.355	640	6.0
11	591	0.381	641	6.1
12	592	0.519	642	6.1
13	593	0.537	643	6.26
14	594	0.672	644	6.26
15	595	0.672	645	6.55
16	596	0.761	646	6.55
17	597	0.761	647	6.26
18	598	0.96	648	6.26
19	599	0.96	649	6.04
20	600	0.979	650	6.04
21	601	0.979	651	4.58
22	602	1.0	652	4.58
23	603	9999999.	653	9999999.
24	604		654	
25	605		655	
26	606		656	
27	607		657	
28	608		658	
29	609		659	
30	610		660	
31	611		661	
32	612		662	
33	613		663	
34	614		664	
35	615		665	
36	616		666	
37	617		667	
38	618		668	
39	619		669	
40	620		670	
41	621		671	
42	622		672	
43	623		673	
44	624		674	
45	625		675	
46	626		676	
47	627		677	
48	628		678	
49	629		679	

Point	Loc	r(in)or r/R	Loc	$EI\times10^{-6}$ lb in^2
1	681	8.	731	1159.
2	682	0.082	732	1159.
3	683	0.082	733	364.
4	684	0.125	734	364.
5	685	0.125	735	265.
6	686	0.135	736	300.
7	687	0.187	737	79.2
8	688	0.342	738	70.3
9	689	0.381	739	59.2
10	690	0.519	740	59.2
11	691	0.537	741	50.9
12	692	0.96	742	50.9
13	693	0.96	743	55.1
14	694	1.0	744	55.1
15	695	9999999.	745	9999999.
16	696		746	
17	697		747	
18	698		748	
19	699		749	
20	700		750	
21	701		751	
22	702		752	
23	703		753	
24	704		754	
25	705		755	
26	706		756	
27	707		757	
28	708		758	
29	709		759	
30	710		760	
31	711		761	
32	712		762	
33	713		763	
34	714		764	
35	715		765	
36	716		766	
37	717		767	
38	718		768	
39	719		769	
40	720		770	
41	721		771	
42	722		772	
43	723		773	
44	724		774	
45	725		775	
46	726		776	
47	727		777	
48	728		778	
49	729		779	
50	730		780	

	Loc	No.
Lag EI Case No.	790	1.

Point	Loc	r(in)or r/R	Loc	EIx10^{-6} lb in^2
1	791	29.5	841	365.
2	792	0.125	842	365.
3	793	0.125	843	270.
4	794	0.187	844	4[illegible]3.
5	795	0.267	845	1524.
6	796	0.295	846	1500.
7	797	0.342	847	1615.
8	798	0.381	848	1606.
9	799	0.519	849	1606.
10	800	0.537	850	1546.
11	801	0.672	851	1546.
12	802	0.672	852	1965.
13	803	0.761	853	1965.
14	804	0.761	854	1546.
15	805	0.960	855	1546.
16	806	0.960	856	1603.
17	807	1.0	857	1603.
18	808	9999999.	858	9999999.
19	809		859	
20	810		860	
21	811		861	
22	812		862	
23	813		863	
24	814		864	
25	815		865	
26	816		866	
27	817		867	
28	818		868	
29	819		869	
30	820		870	
31	821		871	
32	822		872	
33	823		873	
34	824		874	
35	825		875	
36	826		876	
37	827		877	
38	828		878	
39	829		879	
40	830		880	
41	831		881	
42	832		882	
43	833		883	
44	834		884	
45	835		885	
46	836		886	
47	837		887	
48	838		888	
49	839		889	
50	840		890	

	Loc	No.
Torsional Rigidity Case	900	1.

Point	Loc	r(in)or r/R	Loc	GJx10^{-6} lb in^2
1	901	8.	951	202.
2	902	0.125	952	202.
3	903	0.165	953	190.
4	904	0.1875	954	95.
5	905	0.294	955	82.1
6	906	0.339	956	65.2
7	907	0.342	957	75.2
8	908	0.381	958	60.0
9	909	0.519	959	60.0
10	910	0.537	960	49.5
11	911	1.0	961	49.5
12	912	9999999.	962	9999999.
13	913		963	
14	914		964	
15	915		965	
16	916		966	
17	917		967	
18	918		968	
19	919		969	
20	920		970	
21	921		971	
22	922		972	
23	923		973	
24	924		974	
25	925		975	
26	926		976	
27	927		977	
28	928		978	
29	929		979	
30	930		980	
31	931		981	
32	932		982	
33	933		983	
34	934		984	
35	935		985	
36	936		986	
37	937		987	
38	938		988	
39	939		989	
40	940		990	
41	941		991	
42	942		992	
43	943		993	
44	944		994	
45	945		995	
46	946		996	
47	947		997	
48	948		998	
49	949		999	
50	950		1000	

CH47C SOLID TRAILING EDGE PAGE 1

CASE I

PROG CTL= 1.	KQ= 0.0	NB= 10.	CN= 3.
FLAP BNDY= 1.	CW= 0.2300000E 03	E= 0.0	MHB= 0.0
ENG BNDY= 1.	WS= 0.0	KZETA= 0.0	MHZ= 0.0
R= 0.3000000E 02	WF= 0.4979999E 02	EBETA= 0.8000000E 01	KB= 0.0
CZ= 0.2525000E 02	DW= 0.2000000E 00	EZETA= 0.2950000E 02	
EE= 0.1900000E 01	N= 15.	CS= 0.7000000E 05	
B= 0.1025000E 02	INPUT FNB= 1.	IF= 0.0	
KZ= 0.1185000E 05	DOF= 1.	IL= 0.0	

PRINT OUT OF INPUT VALUES IN D07 PART

ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE	ITEM	VALUE
100	0.0	101	1.0000E 00	102	0.0	103	1.0000E 00	104	1.0000E 00	105	0.0
106	1.0000E 00	107	1.0000E 00	108	1.0000E 00	109	0.0	110	1.0000E 00	111	3.6000E 02
112	9.9000E-01	113	9.5000E-01	114	9.0000E-01	115	8.0000E-01	116	7.0000E-01	117	6.0000E-01
118	5.0000E-01	119	4.0000E-01	120	3.0000E-01	121	1.9500E-01	122	1.8000E-01	123	1.6000E-01
124	1.3200E-01	125	2.9500E 01	126	8.0000E 00	127	1.0000E 07	162	2.9500E 01		
170	1.0000E 00	171	8.0000E 00	172	2.5000E-02	173	2.5000E-02	174	5.0000E-02	175	5.0000E-02
176	7.5000E-02	177	7.5000E-02	178	1.0000E-01	179	1.0000E-01	180	1.2500E-01	181	1.2500E-01
182	1.9200E-01	183	1.9200E-01	184	2.6700E-01	185	2.6700E-01	186	3.4200E-01	187	3.4200E-01
188	3.8100E-01	189	5.1900E-01	190	5.3700E-01	191	6.7200E-01	192	6.7200E-01	193	7.6100E-01
194	7.6100E-01	195	9.6000E-01	196	9.6000E-01	197	9.6700E-01	198	9.6700E-01	199	9.7900E-01
200	9.7900E-01	201	1.0000E 00	202	1.0000E 07	271	8.0100E 00	272	8.0100E 00	273	6.2400E 00
274	6.2400E 00	275	9.2500E 00	276	9.2500E 00	277	5.0100E 00	278	5.0100E 00	279	3.3700E 00
280	3.3700E 00	281	8.4000E-01	282	8.4000E-01	283	1.0850E 00	284	9.9000E-01	285	9.2000E-01
286	1.0120E 00	287	9.0000E-01	288	8.5000E-01	289	8.5000E-01	290	7.6000E-01	291	7.6000E-01
292	7.7200E-01	293	7.7200E-01	294	7.6000E-01	295	7.6000E-01	296	7.8000E-01	297	7.8000E-01
298	8.3000E-01	299	8.3000E-01	300	1.8080E 00	301	1.8080E 00	302	1.0000E 07		
470	1.0000E 00	471	8.0000E 00	472	4.3000E-02	473	4.3000E-02	474	9.2000E-02	475	9.2000E-02
476	1.2500E-01	477	1.2500E-01	478	1.4000E-01	479	1.9200E-01	480	1.9200E-01	481	2.6700E-01
482	2.6700E-01	483	3.4200E-01	484	3.8100E-01	485	5.1900E-01	486	5.3700E-01	487	6.7200E-01
488	6.7200E-01	489	7.6100E-01	490	7.6100E-01	491	9.6000E-01	492	9.7900E-01	493	9.7900E-01
494	1.0000E 00	495	1.0000E 07	521	1.8870E 01	522	1.8670E 01	523	1.5840E 01	524	1.5840E 01
525	6.9600E 00	526	6.9600E 00	527	1.3500E 00	528	1.5530E 00	529	1.3770E 00	530	1.0480E 01
531	1.0300E 01	532	7.4000E 00	533	7.9700E 00	534	7.6100E 00	535	7.6100E 00	536	7.4800E 00
537	7.4800E 00	538	8.7500E 00	539	8.7500E 00	540	7.4800E 00	541	7.6100E 00	542	7.6100E 00
543	1.1340E 01	544	1.1340E 01	545	1.0000E 07						
571	1.0000E 00	572	2.5250E 01	573	4.9240E 00	581	8.0000E 00	582	1.6500E-01	583	1.9200E-01
584	1.9200E-01	585	2.6700E-01	586	2.6700E-01	587	2.8300E-01	588	3.4200E-01	589	3.4200E-01
590	3.5500E-01	591	3.8100E-01	592	5.1900E-01	593	5.3700E-01	594	6.7200E-01	595	6.7200E-01
596	7.6100E-01	597	7.6100E-01	598	9.6000E-01	599	9.6000E-01	600	9.7900E-01	601	9.7900E-01
602	1.0000E 00	603	1.0000E 07	631	4.9300E 00	632	4.9300E 00	633	4.7700E 00	634	7.2200E 00
635	7.4100E 00	636	6.7100E 00	637	6.7500E 00	638	5.7000E 00	639	6.2000E 00	640	6.0000E 00
641	6.1000E 00	642	6.1000E 00	643	6.2600E 00	644	6.2600E 00	645	6.5500E 00	646	6.5500E 00
647	6.2600E 00	648	6.2600E 00	649	6.0400E 00	650	6.0400E 00	651	4.5800E 00	652	4.5800E 00
653	1.0000E 07										
680	1.0000E 00	681	8.0000E 00	682	8.2000E-02	683	8.2000E-02	684	1.2500E-01	685	1.2500E-01
686	1.3500E-01	687	1.8700E-01	688	3.4200E-01	689	3.8100E-01	690	5.1900E-01	691	5.3700E-01
692	9.6000E-01	693	9.6000E-01	694	1.0000E 00	695	1.0000E 07	731	1.1590E 03	732	1.1590E 03
733	3.6400E 02	734	3.6400E 02	735	2.6500E 02	736	3.0000E 02	737	7.9200E 01	738	7.0300E 01
739	5.9200E 01	740	5.9200E 01	741	5.0900E 01	742	5.0900E 01	743	5.5100E 01	744	5.5100E 01
745	1.0000E 07										
790	1.0000E 00	791	2.9500E 01	792	1.2500E-01	793	1.2500E-01	794	1.8700E-01	795	2.6700E-01
796	2.9500E-01	797	3.4200E-01	798	3.8100E-01	799	5.1900E-01	800	5.3700E-01	801	6.7200E-01
802	6.7200E-01	803	7.6100E-01	804	7.6100E-01	805	9.6000E-01	806	9.6000E-01	807	1.0000E 00
808	1.0000E 07	841	3.6500E 02	842	3.6500E 02	843	2.7000E 02	844	4.6300E 02	845	1.5240E 03
846	1.5000E 03	847	1.6150E 03	848	1.6060E 03	849	1.6060E 03	850	1.5460E 03	851	1.5460E 03
852	1.9650E 03	853	1.9650E 03	854	1.5460E 03	855	1.5460E 03	856	1.6030E 03	857	1.6030E 03
858	1.0000E 07										
900	1.0000E 00	901	8.0000E 00	902	1.2500E-01	903	1.6500E-01	904	1.8750E-01	905	2.9400E-01
906	3.3900E-01	907	3.4200E-01	908	3.8100E-01	909	5.1900E-01	910	5.3700E-01	911	1.0000E 00
912	1.0000E 07	951	2.0200E 02	952	2.0200E 02	953	1.9000E 02	954	9.5000E 01	955	8.2100E 01
956	6.5200E 01	957	7.5200E 01	958	6.0000E 01	959	6.0000E 01	960	4.9500E 01	961	4.9500E 01
962	1.0000E 07										

PRINCIPAL DIMENSIONS

CASE	1.		
	IN	FT	ILR/R
R RAD	360.000	30.00000	1.00000000
LAG	29.500	2.45833	0.08194441
FLAP	8.000	0.66667	0.02222222

SECTION DETAILS

CASE 1.0 SECTN	MASS / R IN	WT / RBETA	ILR/R / RZETA
1	0.1684517E-01	0.6508975E 01	0.9949998E 00
	0.3582000E 03	0.3502000E 03	0.3287000E 03
2	0.3957659E-01	0.1544695E 02	0.9699991E 00
	0.3491997E 03	0.3411997E 03	0.3196997E 03
3	0.3540371E-01	0.1367999E 02	0.9249993E 00
	0.3329998E 03	0.3249998E 03	0.3034998E 03
4	0.7080740E-01	0.2735999E 02	0.8499993E 00
	0.3059998E 03	0.2979998E 03	0.2764998E 03
5	0.7148892E-01	0.2762332E 02	0.7499993E 00
	0.2699998E 03	0.2619998E 03	0.2404998E 03
6	0.7112044E-01	0.2748094E 02	0.6499996E 00
	0.2339999E 03	0.2259999E 03	0.2044999E 03
7	0.7315516E-01	0.2826715E 02	0.5499997E 00
	0.1979999E 03	0.1899999E 03	0.1684999E 03
8	0.7919258E-01	0.3060001E 02	0.4499996E 00
	0.1619399E 03	0.1539999E 03	0.1324999E 03
9	0.8543195E-01	0.3301093E 02	0.3499999E 00
	0.1260000E 03	0.1180000E 03	0.9649997E 02
10	0.9837663E-01	0.3801274E 02	0.2474999E 00
	0.8909998E 02	0.8109998E 02	0.5959998E 02
11	0.1241866E-01	0.4798569E 01	0.1874999E 00
	0.6749998E 02	0.5949998E 02	0.3799998E 02
12	0.1565216E-01	0.6047995E 01	0.1699999E 00
	0.6119997E 02	0.5319997E 02	0.3169997E 02
13	0.2191299E-01	0.8467178E 01	0.1459999E 00
	0.5255998E 02	0.4455998E 02	0.2305998E 02
14	0.1682498E 00	0.6501173E 02	0.1069722E 00
	0.3850999E 02	0.3050999E 02	0.9009995E 01
15	0.4139363E 00	0.1599449E 03	0.5208333E-01
	0.1875000E 02	0.1075000E 02	-0.1075000E 02

	WT / P	MASS / PS2/I	1 ST / PS2	2 ND / PS2I
HUB			0.1534265E 03	0.3443515E 05
FLAP	0.4922598E 03	0.1273965E 01	0.1432348E 03	0.3206186E 05
LAG	0.3323162E 03	0.8600321E 00	0.1202943E 03	0.2642786E 05

G=386.4 I/S2

First Mass Moment about Flap Hinge (Multiply by 12 and input in A97 Locs. 37 & 58)

Second Mass Moment about Flap Hinge (Divide by 12 and input in A97 Locs. 36 & 57)

PITCH INERTIA DISTRIBUTION

PRINCIPAL DIMENSIONS

CASE 1.

	IN	FT	ILR/R
R RAD	360.000	30.00000	1.00000000
FLAP	8.000	0.66667	0.02222222

SECTION DETAILS

CASE 1.0

SECTN	PITCH	ILR/R	R IN	RBETA
1	0.4082510	0.9949998	358.1999512	350.1999512
2	1.2434387	0.9699991	349.1997070	341.1997070
3	1.3656826	0.9249993	332.9997559	324.9997559
4	2.7137280	0.8499993	305.9997559	297.9997559
5	2.9734612	0.7499993	269.9997559	261.9997559
6	2.8208132	0.6499996	233.9998779	225.9998779
7	2.7059002	0.5499997	197.9998779	189.9998779
8	2.7396002	0.4499996	161.9998779	153.9998779
9	2.7951708	0.3499999	125.9999695	117.9999695
10	3.5861673	0.2474999	89.0999756	81.0999756
11	0.1735106	0.1874999	67.4999847	59.4999847
12	0.1045051	0.1699999	61.1999664	53.1999664
13	0.1525461	0.1459999	52.5599823	44.5599823
14	1.4354658	0.1069722	38.5099945	30.5099945
15	3.6322412	0.0520833	18.7500000	10.7500000

PITCH INERTIA TOTAL

0.2885043E 02

CHORD CENTROID IN AFT LE
PRINCIPAL DIMENSIONS

CASE	1.		
	IN	FT	ILR/R
R RAD	360.000	30.00000	1.00000000
FLAP	8.000	0.66667	0.02222222

SECTION DETAILS

CASE	1.0	
	IN	FT	ILR/R
BLCRD	25.250	2.10417	
PITCH	4.924	0.41033	

SECTN	INAFT YN	(AFT R IN	ILR/R RBETA
1	0.4579996E 01	-0.1362390E 01	0.9945998E 00
	-0.3440037E 00	0.3582000E 03	0.3502000E 03
2	0.5693506E 01	0.3047549E 01	0.9699991E 00
	0.7695065E 00	0.3491997E 03	0.3411997E 03
3	0.6259998E 01	0.5291082E 01	0.9249993E 00
	0.1335999E 01	0.3329998E 03	0.3249998E 03
4	0.6259995E 01	0.5291071E 01	0.8499993E 00
	0.1335996E 01	0.3059998E 03	0.2979998E 03
5	0.6436898E 01	0.5991676E 01	0.7499993E 00
	0.1512898E 01	0.2699998E 03	0.2619998E 03
6	0.6341198E 01	0.5612665E 01	0.6499996E 00
	0.1417198E 01	0.2339999E 03	0.2259999E 03
7	0.6215198E 01	0.5113653E 01	0.5499997E 00
	0.1291198E 01	0.1979999E 03	0.1899999E 03
8	0.6099997E 01	0.4657413E 01	0.4499996E 00
	0.1175997E 01	0.1619999E 03	0.1539999E 03
9	0.6075965E 01	0.4562237E 01	0.3499999E 00
	0.1151965E 01	0.1260000E 03	0.1180000E 03
10	0.7112493E 01	0.8667297E 01	0.2474999E 00
	0.2188493E 01	0.8909998E 02	0.8109998E 02
11	0.5289206E 01	0.1446359E 01	0.1874999E 00
	0.3652058E 00	0.6749998E 02	0.5949998E 02
12	0.4896664E 01	-0.1082618E 00	0.1699999E 00
	-0.2733612E-01	0.6119997E 02	0.5319997E 02
13	0.4929598E 01	0.2375688E-01	0.1459959E 00
	0.5998611E-02	0.5255998E 02	0.4455998E 02
14	0.4929598E 01	0.2375688E-01	0.1069722E 00
	0.5998611E-02	0.3850999E 02	0.3050999E 02
15	0.4929998E 01	0.2375688E-01	0.5208333E-01
	0.5998611E-02	0.1875000E 02	0.1075000E 02

FLAP EI

PRINCIPAL DIMENSIONS

CASE	1.		
	IN	FT	ILR/R
R RAD	360.000	30.00000	1.0000000
FLAP	3.000	0.66667	0.02222222

SECTION DETAILS

CASE 1.0

SECTN	EIPI2 / ILR/R INNER	DL IN / R IN INNER	ILR/R OUTER	R IN OUTER
1- 2	0.5510000E 08	0.9000244E 01		
	0.9699991E 00	0.3491997E 03	0.9949998E 00	0.3582000E 03
2- 3	0.5177701E 08	0.1619995E 02		
	0.9249993E 00	0.3329998E 03	0.9699991E 00	0.3491997E 03
3- 4	0.5089998E 08	0.2700000E 02		
	0.8499993E 00	0.3059998E 03	0.9249993E 00	0.3329998E 03
4- 5	0.5089998E 08	0.3600000E 02		
	0.7499993E 00	0.2699998E 03	0.8499993E 00	0.3059998E 03
5- 6	0.5089998E 08	0.3599988E 02		
	0.6499996E 00	0.2339999E 03	0.7499993E 00	0.2699998E 03
6- 7	0.5089998E 08	0.3600000E 02		
	0.5499997E 00	0.1979999E 03	0.6499996E 00	0.2339999E 03
7- 8	0.5719058E 08	0.3600000E 02		
	0.4499996E 00	0.1619999E 03	0.5499997E 00	0.1979999E 03
8- 9	0.6047203E 08	0.3599991E 02		
	0.3499999E 00	0.1260000E 03	0.4499996E 00	0.1619999E 03
9-10	0.7266576E 08	0.3689999E 02		
	0.2474999E 00	0.8909998E 02	0.3499999E 00	0.1260000E 03
10-11	0.7743582E 08	0.2159999E 02		
	0.1874999E 00	0.6749998E 02	0.2474999E 00	0.8909998E 02
11-12	0.1101406E 09	0.6300018E 01		
	0.1699999E 00	0.6119997E 02	0.1874999E 00	0.6749998E 02
12-13	0.1979866E 09	0.8639984E 01		
	0.1459999E 00	0.5255998E 02	0.1699999E 00	0.6119997E 02
13-14	0.3126543E 09	0.1404999E 02		
	0.1069722E 00	0.3850999E 02	0.1459999E 00	0.5255998E 02
14-15	0.5813412E 09	0.1975999E 02		
	0.5208333E-01	0.1875000E 02	0.1069722E 00	0.3850999E 02
15-16	0.1159000E 10	0.1075000E 02		
	0.2222222E-01	0.8000000E 01	0.5208333E-01	0.1875000E 02

INVERSE MEAN EI= 0.6571522E 08

Similar Output for Lag EI and GJ

CH47C SOLID TRAILING EDGE PAGE 8

N	XN	W	DM	I	YZ	EIFLAP	GJ	EILAG
1	360.00000	0.01685	0.0	0.40825	-0.34400	0.55100E 08	0.49500E 08	0.16030F 1
2	356.39990	0.03998	0.0	1.24344	0.76951	0.51777E 08	0.49500E 08	0.15583F 10
3	341.99976	0.03540	0.0	1.36568	1.33600	0.50900E 08	0.49500E 08	0.15460F 10
4	323.99976	0.07081	0.0	2.71373	1.33600	0.50900E 08	0.49500E 08	0.15831E 1
5	287.99976	0.07149	0.0	2.97346	1.51290	0.50900E 08	0.49500E 08	0.18544F 1
6	251.99998	0.07112	0.0	2.82081	1.41720	0.50900E 08	0.49500E 08	0.15460F 1
7	215.99998	0.07316	0.0	2.70590	1.29120	0.57191E 08	0.57392E 08	0.15925F 1
8	180.00000	0.07919	0.0	2.73960	1.17600	0.60472E 08	0.61701E 08	0.16071F 1
9	143.99998	0.08543	0.0	2.79517	1.15197	0.72666E 08	0.76068E 08	0.15143E 1
10	107.99997	0.09838	0.0	3.58617	2.18849	0.77436E 08	0.91318E 08	0.80283E 0
11	70.20000	0.01242	0.0	0.17351	0.36521	0.11014E 09	0.12842E 09	0.43682E 0
12	64.79997	0.01565	0.0	0.10451	-0.02734	0.19799E 09	0.18984E 09	0.37148E 0
13	57.59998	0.02191	0.0	0.15255	0.00600	0.31265E 09	0.20028E 09	0.32785F 0
14	47.51999	0.16825	0.0	1.43547	0.00600	0.58134E 09	0.20200E 09	0.36500E 0
15	29.50000	0.41394	0.0	3.63224	0.00600	0.11590E 10	0.20200E 09	0.36500F 0
16	8.00000							

CH47C SOLID TRAILING EDGE PAGE 9

AX	AY	AGAMMA	SIGMA I	I I
3500.36743	-18.80156	-1204.13916	-0.00579	0.00199
11598.63281	-37.59766	5196.74219	0.03076	0.02367
18437.87203	-42.60899	14942.97556	0.04739	0.06319
31007.16016	-52.63177	32885.98438	0.09460	0.12638
42204.49219	-55.41458	51721.15234	0.10816	0.16363
51858.82813	-62.13142	67398.12500	0.10079	0.14284
60261.59766	-74.38768	80484.43750	0.09446	0.12196
67703.93750	-92.94783	91914.56250	0.09313	0.10952
73948.50000	-114.16132	102454.12500	0.09841	0.11337
79033.37500	-79.43491	117794.87500	0.21530	0.47117
79519.62500	-88.18655	119688.18750	0.00454	0.00166
80075.31250	-102.78119	120228.56250	-0.00043	0.00001
80743.43750	-122.78990	121120.56250	0.00013	0.00000
84502.12500	-276.41846	122868.25000	0.00101	0.00001
89004.50000	-654.38306	128357.25000	0.00248	0.00001

ARB= 135391.81250

UNCOUPLED FLAP BENDING

FREQUENCY SWEEP KK=250

W	CPS	OMEGA RAD.	DOMEGA	W	CPS	OMEGA RAD.	DOMEGA
W 1	0.0	0.0	-0.6822207E 10	W 51	10.0	0.6283130E 02	-0.1431674E 09
W 2	0.2	0.1256637E 01	-0.6800167E 10	W 52	10.2	0.6408792E 02	-0.1060790E 10
W 3	0.4	0.2513273E 01	-0.6734328E 10	W 53	10.4	0.6534454E 02	-0.2032496E 10
W 4	0.6	0.3769910E 01	-0.6625030E 10	W 54	10.6	0.6660117E 02	-0.3054670E 10
W 5	0.8	0.5026546E 01	-0.6472950E 10	W 55	10.8	0.6785779E 02	-0.4123154E 10
W 6	1.0	0.6283193E 01	-0.6279074E 10	W 56	11.0	0.6911441E 02	-0.5233533E 10
W 7	1.2	0.7539820E 01	-0.6044561E 10	W 57	11.2	0.7037103E 02	-0.6380786E 10
W 8	1.4	0.8796456E 01	-0.5770887E 10	W 58	11.4	0.71627[illegible]E 02	-0.7559537E 10
W 9	1.6	0.1005309E 02	-0.5459755E 10	W 59	11.6	0.7288428E 02	-0.8763990E 10
W 10	1.8	0.1130973E 02	-0.5113131E 10	W 60	11.8	0.7414090E 02	-0.9987875E 10
W 11	2.0	0.1256637E 02	-0.4733219E 10	W 61	12.0	0.7539752E 02	-0.1122454E 11
W 12	2.2	0.1382300E 02	-0.4322386E 10	W 62	12.2	0.7665414E 02	-0.1246694E 11
W 13	2.4	0.1507964E 02	-0.38833[illegible]3E 10	W 63	12.4	0.7791077E 02	-0.1370765E 11
W 14	2.6	0.1633627E 02	-0.34108[illegible]7E 10	W 64	12.6	0.7916739E 02	-0.1493882E 11
W 15	2.8	0.1759290E 02	-0.2931872E 10	W 65	12.8	0.8042401E 02	-0.1615231E 11
W 16	3.0	0.1884952E 02	-0.2425723E 10	W 66	13.0	0.8168063E 02	-0.1733957E 11
W 17	3.2	0.2010614E 02	-0.1903725E 10	W 67	13.2	0.8293726E 02	-0.1849179E 11
W 18	3.4	0.2136276E 02	-0.1369373E 10	W 68	13.4	0.8419388E 02	-0.1959986E 11
W 19	3.6	0.2261938E 02	-0.8262835E 09	W 69	13.6	0.8545050E 02	-0.2065440E 11
W 20	3.8	0.2387601E 02	-0.2782164E 09	W 70	13.8	0.8670712E 02	-0.2164566E 11
W 21	4.0	0.2513263E 02	0.2709929E 09	W 71	14.0	0.8796375E 02	-0.2256393E 11
W 22	4.2	0.2638925E 02	0.8174234E 09	W 72	14.2	0.8922037E 02	-0.2339918E 11
W 23	4.4	0.2764587E 02	0.1357095E 10	W 73	14.4	0.9047699E 02	-0.2414105E 11
W 24	4.6	0.2890250E 02	0.1886002E 10	W 74	14.6	0.9173361E 02	-0.2477935E 11
W 25	4.8	0.3015912E 02	0.2400108E 10	W 75	14.8	0.9299023E 02	-0.2530369E 11
W 26	5.0	0.3141574E 02	0.2895385E 10	W 76	15.0	0.9424686E 02	-0.2570354E 11
W 27	5.2	0.3267236E 02	0.3367818E 10	W 77	15.2	0.9550348E 02	-0.2596852E 11
W 28	5.4	0.3392899E 02	0.3813443E 10	W 78	15.4	0.9676010E 02	-0.2608812E 11
W 29	5.6	0.3518561E 02	0.4228363E 10	W 79	15.6	0.9801672E 02	-0.2605207E 11
W 30	5.8	0.3644223E 02	0.4608737E 10	W 80	15.8	0.9927335E 02	-0.2584998E 11
W 31	6.0	0.3769885E 02	0.4950893E 10	W 81	16.0	0.1005300E 03	-0.2547194E 11
W 32	6.2	0.3895547E 02	0.5251215E 10	W 82	16.2	0.1017866E 03	-0.2490797E 11
W 33	6.4	0.4021210E 02	0.5506281E 10	W 83	16.4	0.1030432E 03	-0.2414839E 11
W 34	6.6	0.4146872E 02	0.5712835E 10	W 84	16.6	0.1042998E 03	-0.2318391E 11
W 35	6.8	0.4272534E 02	0.5867794E 10	W 85	16.8	0.1055565E 03	-0.2200556E 11
W 36	7.0	0.4398196E 02	0.5968286E 10	W 86	17.0	0.1068131E 03	-0.2060471E 11
W 37	7.2	0.4523859E 02	0.6011703E 10	W 87	17.2	0.1080697E 03	-0.1897316E 11
W 38	7.4	0.4649521E 02	0.5995639E 10	W 88	17.4	0.1093263E 03	-0.1710342E 11
W 39	7.6	0.4775183E 02	0.5917995E 10	W 89	17.6	0.1105829E 03	-0.1498827E 11
W 40	7.8	0.4900845E 02	0.5776953E 10	W 90	17.8	0.1118396E 03	-0.1262119E 11
W 41	8.0	0.5026508E 02	0.5570986E 10	W 91	18.0	0.1130962E 03	-0.9996431E 10
W 42	8.2	0.5152170E 02	0.5298913E 10	W 92	18.2	0.1143528E 03	-0.7108809E 10
W 43	8.4	0.5277832E 02	0.4959846E 10	W 93	18.4	0.1156094E 03	-0.3953926E 10
W 44	8.6	0.5403494E 02	0.4553327E 10	W 94	18.6	0.1168661E 03	-0.5282931E 09
W 45	8.8	0.5529156E 02	0.4079209E 10	W 95	18.8	0.1181227E 03	0.3170784E 10
W 46	9.0	0.5654819E 02	0.3537710E 10	W 96	19.0	0.1193793E 03	0.7145140E 10
W 47	9.2	0.5780481E 02	0.2929524E 10	W 97	19.2	0.1206359E 03	0.1139544E 11
W 48	9.4	0.5906143E 02	0.2255670E 10	W 98	19.4	0.1218925E 03	0.1592157E 11
W 49	9.6	0.6031805E 02	0.1517591E 10	W 99	19.6	0.1231492E 03	0.2072214E 11
W 50	9.8	0.6157468E 02	0.7172175E 09	W100	19.8	0.1244058E 03	0.2579476E 11

Similar Output up to W250

```
INDICATOR FOR ITERATION IS     3
W 20     OMEGA= 0.2387601E 02     DOMEGA=-0.2782164E 09
W 21     OMEGA= 0.2513263E 02     DOMEGA= 0.2709929E 09

ARRAY OF ITERATED W AND DW BETWEEN W 20     AND W 21

                    OMEGA              DOMEGA
      W  1       0.2451257E 02       0.1050271E 06
      W  2       0.2451231E 02      -0.1005135E 05
      W  3       0.2451233E 02      -0.3445204E 04


FINAL COLAPS MATRIX
        -0.2817675D 08     0.8148195D 05     0.0
        -0.8414707D 10     0.2426077D 08     0.0
         0.1459301D 04    -0.4204556D 01     0.0
        -0.9676938D 05     0.2789996D 03     0.0
         0.0               0.0              -0.1239377D 07
         0.0               0.0               0.9966716D 00
```

CH47C SOLID TRAILING EDGE PAGE 14

FREQUENCY PER REV.= 0.1017719E 01

VZ	MY	BETA	Z	MX	THETA
0.0	0.0	0.2883159D-02	0.1000000D 01	0.0	0.0
0.1012149D 02	0.2652535D 00	0.2883115D-02	0.9740507D 00	0.0	0.0
0.3351829D 02	0.1550577D 01	0.2862833D-02	0.9273455D 00	0.0	0.0
0.5324521D 02	0.4349081D 01	0.2881349D-02	0.8495256D 00	0.0	0.0
0.8338821D 02	0.7931860D 01	0.2877689D-02	0.7453591D 00	0.0	0.0
0.1214261D 03	0.1112296D 02	0.2872400D-02	0.6423592D 00	0.0	0.0
0.1488761D 03	0.1481295D 02	0.2865593D-02	0.5390314D 00	0.0	0.0
0.1725717D 03	0.1991339D 02	0.2857552D-02	0.4360721D 00	0.0	0.0
0.1933214D 03	0.2782993D 02	0.2847261D-02	0.3333948D 00	0.0	0.0
0.2104353D 03	0.4187094D 02	0.2834209D-02	0.2285781D 00	0.0	0.0
0.2239466D 03	0.5066191D 02	0.2822682D-02	0.1674841D 00	0.0	0.0
0.2251963D 03	0.5605739D 02	0.2819649D-02	0.1497105D 00	0.0	0.0
0.2266043D 03	0.6402402D 02	0.2817048D-02	0.1253597D 00	0.0	0.0
0.2282548D 03	0.7694516D 02	0.2813917D-02	0.8530155D-01	0.0	0.0
0.2369288D 03	0.6211239D 02	0.2811587D-02	0.3022251D-01	0.0	0.0
0.2444456D 03	-0.3560222D-01	0.2811298D-02	-0.1133095D-12	0.0	0.0
0.2444456D 03	-0.3560222D-01	0.2811293D-02	-0.1133095D-12	0.0	0.0

GEN. FLAP MASS = 0.25905150E 00

GEN. PITCH INERTIA = 0.0

Similar Output for Other Natural Frequencies

COUPLED FLAP BENDING TORSION.

ROTOR SPEED = 230. RPM

MODE NUMBER	FREQUENCY RPS	FREQUENCY CPM	FREQUENCY PER REV
1	2.4512329E 01	2.3407550E 02	1.0177193E 00
2	6.2527945E 01	5.9805273E 02	2.6002293E 00
3	1.1705135E 02	1.1177576E 03	4.8598175E 00
4	1.9555931E 02	1.8674539E 03	8.1193647E 00
5	3.0094556E 02	2.8738179E 03	1.2494864E 01

NERR=0 5 MODES.

RESULTANT MATRIX FOR CRTHOGONALITY CHECK

0.2590515E 00	0.3984431E-05	0.3106659E-05	-0.1[illegible]771E-05	0.1535778E-05
0.3980938E-05	0.1908165E 00	0.2114880E-02	0.1720805E-03	0.1407494E-03
0.3099442E-05	0.2114880E-02	0.2223307E 00	0.9941395E-02	0.3105896E-03
-0.1986273E-05	0.1720954E-03	0.9941395E-02	0.2500014E 00	0.2404469E-01
0.1520384E-05	0.1407717E-03	0.3106008E-03	0.2404959E-01	0.2630276E 00

CH47C SOLID TRAILING EDGE

NORMALIZED MATRIX FOR ORTHOGONALITY CHECK.

0.9999989E 00	0.1792111E-04	0.1294496E-04	-0.751[illegible]770E-05	0.5894974E-05
0.1790539E-04	0.9999992E 00	0.1026781E-01	0.7576654E-03	0.6282572E-03
0.1291488E-04	0.1026781E-01	0.9999999E 00	0.4216735E-01	0.3351974E-02
-0.7805046E-05	0.7879334E-03	0.4216735E-01	0.9999996E 00	0.9378538E-01
0.5824509E-05	0.6283568E-03	0.3352020E-02	0.9376568E-01	0.9999999E 00

EFFECTIVE MASS, DAMPING, AND MOMENT OF INERTIA IN FLAP BENDING TORSION.

WZ	CPS	MBAR	CBARH	IBAR	CBARI
W 1	0.0	0.2433943E 01	0.3737463E 02	-0.2961899E 08	[illegible] 07
W 2	0.2	0.2430650E 01	0.3749422E 02	-0.1862213E 08	-0.1[illegible] 07
W 3	0.4	0.2420612E 01	0.3785703E 02	-0.4556826E 07	-0.1[illegible] 07
W 4	0.6	0.2403345E 01	0.3846492E 02	-0.1961914E 07	-0.9[illegible] 06
W 5	0.8	0.2378126E 01	0.3932149E 02	-0.1060447E 07	-0.[illegible] 06
W 6	1.0	0.2343787E 01	0.4043177E 02	-0.6498265E 06	-0.[illegible] 06
W 7	1.2	0.2298916E 01	0.4179562E 02	-0.4321041E 06	-0.5745747E 06
W 8	1.4	0.2241784E 01	0.4340901E 02	-0.3048797E 06	-0.4642460E 06
W 9	1.6	0.2170458E 01	0.4525653E 02	-0.2252234E 06	-0.3660570E 06
W 10	1.8	0.2082949E 01	0.4730540E 02	-0.1725348E 06	-0.2814015E 06
W 11	2.0	0.1977533E 01	0.4945727E 02	-0.1363809E 06	-0.2096579E 06
W 12	2.2	0.1853214E 01	0.5173945E 02	-0.1104526E 06	-0.1504[illegible] 06
W 13	2.4	0.1710385E 01	0.5384795E 02	-0.9131194E 05	-0.1017[illegible] 06
W 14	2.6	0.1551583E 01	0.5579756E 02	-0.7678606E 05	-0.6056[illegible] 05
W 15	2.8	0.1382141E 01	0.5723238E 02	-0.6549494E 05	-0.26[illegible] 05
W 16	3.0	0.1210361E 01	0.5799402E 02	-0.5653144E 05	0.1517[illegible] 04
W 17	3.2	0.1046852E 01	0.5791278E 02	-0.4923650E 05	0.2[illegible] 05
W 18	3.4	0.9029245E 00	0.5690224E 02	-0.4333775E 05	0.4[illegible] 05
W 19	3.6	0.7883644E 00	0.5498694E 02	-0.3838669E 05	0.[illegible] 05
W 20	3.8	0.7094412E 00	0.5231074E 02	-0.3421731E 05	0.8106[illegible] 05
W 21	4.0	0.6679611E 00	0.4908456E 02	-0.3067068E 05	0.9651[illegible] 05
W 22	4.2	0.6616077E 00	0.4555684E 02	-0.2762738E 05	0.1107[illegible] 06
W 23	4.4	0.6852064E 00	0.4195740E 02	-0.2499481E 05	0.1247[illegible] 06
W 24	4.6	0.7323170E 00	0.3847305E 02	-0.2270806E 05	0.13[illegible] 06
W 25	4.8	0.7965040E 00	0.3522294E 02	-0.2075706E 05	0.15[illegible] 06
W 26	5.0	0.8721628E 00	0.3229330E 02	-0.1895113E 05	0.16[illegible] 06
W 27	5.2	0.9546435E 00	0.2971866E 02	-0.1740950E 05	0.1[illegible] 06
W 28	5.4	0.1041282E 01	0.2750[illegible] 02	-0.1606183E 05	0.[illegible] 06
W 29	5.6	0.1129240E 01	0.2566267E 02	-0.1493150E 05	0.2[illegible] 06
W 30	5.8	0.1217309E 01	0.2416632E 02	-0.1398446E 05	0.2[illegible] 06
W 31	6.0	0.1304693E 01	0.2300899E 02	-0.1317710E 05	0.2[illegible] 06
W 32	6.2	0.1391052E 01	0.2218301E 02	-0.1264569E 05	0.2[illegible] 06
W 33	6.4	0.1476334E 01	0.2168770E 02	-0.1234338E 05	0.3[illegible] 06
W 34	6.6	0.1560697E 01	0.2153151E 02	-0.1225063E 05	0.34[illegible] 06
W 35	6.8	0.1644403E 01	0.2173465E 02	-0.1232603E 05	0.3[illegible] 06
W 36	7.0	0.1727750E 01	0.2233146E 02	-0.1250494E 05	0.3[illegible] 06
W 37	7.2	0.1811009E 01	0.2337354E 02	-0.1272419E 05	0.3[illegible] 06
W 38	7.4	0.1894318E 01	0.2493341E 02	-0.1291476E 05	0.3558[illegible] 06
W 39	7.6	0.1977599E 01	0.2710916E 02	-0.1303866E 05	0.3355151E 06
W 40	7.8	0.2060358E 01	0.3002431E 02	-0.1305438E 05	0.3175186E 06
W 41	8.0	0.2141473E 01	0.3385725E 02	-0.1295564E 05	0.2[illegible] 06
W 42	8.2	0.2218801E 01	0.3879224E 02	-0.1273266E 05	0.2[illegible] 06
W 43	8.4	0.2288712E 01	0.4506273E 02	-0.1245173E 05	0.2[illegible] 06
W 44	8.6	0.2345424E 01	0.5289975E 02	-0.1219177E 05	0.211[illegible] 06
W 45	8.8	0.2380383E 01	0.6247786E 02	-0.1167821E 05	0.1[illegible] 06
W 46	9.0	0.2382049E 01	0.7380135E 02	-0.1126901E 05	0.1[illegible] 06
W 47	9.2	0.2336893E 01	0.8653015E 02	-0.1062341E 05	0.1[illegible] 06
W 48	9.4	0.2232758E 01	0.9979126E 02	-0.1038909E 05	0.12[illegible] 06
W 49	9.6	0.2064917E 01	0.1121155E 03	-0.9957594E 04	0.1162[illegible] 06
W 50	9.8	0.1842606E 01	0.1210459E 03	-0.9539580E 04	0.1[illegible] 06

Similar Output up to W250

TABLE OF AMPLITUDE AND PHASE ANGLE -- FLAP BENDING TORSION

WZ	CPS	R1	PHI	TAO	PHO
W 1	0.0	0.3745279E 02	-0.8999976E 02	0.2972851E 08	-0.8999976E 02
W 2	0.2	0.2993581E 02	-0.9465723E 02	0.1864181E 08	0.2633774E 01
W 3	0.4	0.1525609E 02	-0.9912939E 02	0.4576717E 07	0.5067866E 01
W 4	0.6	0.1043238E 02	-0.1032544E 03	0.1977184E 07	0.7125514E 01
W 5	0.8	0.8176332E 01	-0.1069089E 03	0.1072733E 07	0.8672913E 01
W 6	1.0	0.6648459E 01	-0.1100129E 03	0.6591244E 06	0.9635162E 01
W 7	1.2	0.6001115E 01	-0.1125247E 03	0.4387763E 06	0.1000169E 02
W 8	1.4	0.5420159E 01	-0.1144312E 03	0.3094139E 06	0.9820938E 01
W 9	1.6	0.4997663E 01	-0.1157402E 03	0.2281478E 06	0.9183701E 01
W 10	1.8	0.4672664E 01	-0.1164727E 03	0.1744186E 06	0.8201416E 01
W 11	2.0	0.4407417E 01	-0.1166592E 03	0.1374006E 06	0.6984772E 01
W 12	2.2	0.4176649E 01	-0.1163466E 03	0.1109979E 06	0.5629059E 01
W 13	2.4	0.3962381E 01	-0.1155725E 03	0.9155856E 05	0.4206635E 01
W 14	2.6	0.3751464E 01	-0.1144307E 03	0.7637556E 05	0.2765187E 01
W 15	2.8	0.3534590E 01	-0.1130183E 03	0.6551265E 05	0.1332469E 01
W 16	3.0	0.3306201E 01	-0.1114744E 03	0.5653149E 05	-0.8152771E-01
W 17	3.2	0.3064692E 01	-0.1099734E 03	0.4930268E 05	-0.1477173E 01
W 18	3.4	0.2812498E 01	-0.1087258E 03	0.4339194E 05	-0.2863815E 01
W 19	3.6	0.2555683E 01	-0.1079673E 03	0.3849279E 05	-0.4255051E 01
W 20	3.8	0.2302934E 01	-0.1079421E 03	0.3438545E 05	-0.5665350E 01
W 21	4.0	0.2064090E 01	-0.1088813E 03	0.3090936E 05	-0.7122360E 01
W 22	4.2	0.1848777E 01	-0.1109688E 03	0.2794432E 05	-0.8637680E 01
W 23	4.4	0.1665184E 01	-0.1142983E 03	0.2540102E 05	-0.1023512E 02
W 24	4.6	0.1519185E 01	-0.1188191E 03	0.2321005E 05	-0.1193813E 02
W 25	4.8	0.1413654E 01	-0.1242937E 03	0.2131990E 05	-0.1377103E 02
W 26	5.0	0.1348079E 01	-0.1303132E 03	0.1969153E 05	-0.1576173E 02
W 27	5.2	0.1318746E 01	-0.1363901E 03	0.1829915E 05	-0.1793941E 02
W 28	5.4	0.1319726E 01	-0.1420933E 03	0.1712372E 05	-0.2032855E 02
W 29	5.6	0.1344300E 01	-0.1471421E 03	0.1617961E 05	-0.2292654E 02
W 30	5.8	0.1386216E 01	-0.1514199E 03	0.1546066E 05	-0.2567113E 02
W 31	6.0	0.1443393E 01	-0.1549297E 03	0.1495003E 05	-0.2839977E 02
W 32	6.2	0.1503095E 01	-0.1577373E 03	0.1473011E 05	-0.3085219E 02
W 33	6.4	0.1571763E 01	-0.1599316E 03	0.1467498E 05	-0.3274174E 02
W 34	6.6	0.1644800E 01	-0.1615981E 03	0.1475209E 05	-0.3385670E 02
W 35	6.8	0.1721292E 01	-0.1628101E 03	0.1488691E 05	-0.3411806E 02
W 36	7.0	0.1800811E 01	-0.1636250E 03	0.1500907E 05	-0.3357535E 02
W 37	7.2	0.1883269E 01	-0.1640767E 03	0.1505362E 05	-0.3235057E 02
W 38	7.4	0.1963759E 01	-0.1641936E 03	0.1501578E 05	-0.3064455E 02
W 39	7.6	0.2057472E 01	-0.1639827E 03	0.1485121E 05	-0.2860362E 02
W 40	7.8	0.2149540E 01	-0.1634377E 03	0.1457368E 05	-0.2639508E 02
W 41	8.0	0.2244907E 01	-0.1625396E 03	0.1419916E 05	-0.2414778E 02
W 42	8.2	0.2343071E 01	-0.1612558E 03	0.1375000E 05	-0.2195676E 02
W 43	8.4	0.2442783E 01	-0.1595415E 03	0.1325058E 05	-0.1988255E 02
W 44	8.6	0.2541542E 01	-0.1573440E 03	0.1272185E 05	-0.1796236E 02
W 45	8.8	0.2634969E 01	-0.1546060E 03	0.1218252E 05	-0.1620990E 02
W 46	9.0	0.2716147E 01	-0.1512817E 03	0.1166634E 05	-0.1462447E 02
W 47	9.2	0.2775228E 01	-0.1473577E 03	0.1112276E 05	-0.1319942E 02
W 48	9.4	0.2800002E 01	-0.1428835E 03	0.1061309E 05	-0.1193091E 02
W 49	9.6	0.2778249E 01	-0.1380083E 03	0.1013629E 05	-0.1077449E 02
W 50	9.8	0.2701979E 01	-0.1329958E 03	0.9673289E 04	-0.9743027E 01

Similar Output up to W250

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NO.	SYM	UNIT	DEFINITION
27	C_F	ft	Forward rotor blade chord length - obtained from the projection of the leading-edge and trailing-edge span lines to the center of rotation
28	b_F	-	Number of blades in the front rotor
29	e_F	ft	Front rotor blade flapping hinge offset (usually written as $e_{\beta F}$)
30	σ_{1F}	-	Increment in solidity at the tip (forward rotor) based on a linear variation from the reference root (input 27, C_F) to the tip: $\sigma_{1F} = b_F\ (C_{TIP} - C_F)/\kappa R_F$
31	θ_{TWF}	deg	Angle of total twist of forward rotor blade from reference root at the centerline of rotation to the tip Positive leading edge up at blade tip
32	X_{CF}	-	Forward rotor radius ratio for blade cutout
33	$k_{\beta F}$	-	Rate of change of front rotor blade pitch angle with rotor blade flap angle. Equal to - tan δ_3
34	i_F	deg	Angle of incidence of the front rotor shaft in the helicopter X - Z plane Positive into the wind
35	V_{TF}	ft/sec	Front rotor blade tipspeed
36	I_F	slugs-ft^2	Mass moment of inertia of the forward rotor blade about the flapping hinge (usually written as $I_{\beta F}$). Obtain from D-01
37	M_{WF}	ft-lb	Weight moment of the forward rotor blade about the flapping hinge in a horizontal position (gM_β). Obtain from D-01

NO.	SYM	UNIT	DEFINITION
38	B_{ITF}	deg	Front rotor longitudinal cyclic pitch angle due to trim devices other than longitudinal control. Generally a function of dynamic pressure
44	l_F	ft	Distance from the helicopter cg to the projection of the front rotor hub on the X axis
45	h_F	ft	Distance from the helicopter cg to the front rotor hub measured parallel to the helicopter Z axis
46	d_F	ft	Lateral distance from helicopter cg to the front rotor shaft
47	R_R	ft	Rear rotor blade radius measured from the center of rotation
48	C_R	ft	Rear rotor blade chord length - obtained from the projection of the leading-edge and trailing-edge span lines to the center of rotation
49	b_R	-	Number of blades in the rear rotor
50	e_R	ft	Rear rotor blade flapping hinge offset (usually written as $e_{\beta R}$)
51	σ_{1R}	-	Increment in solidity at the tip (rear rotor) based on a linear variation from the reference root (input 48, C_R)
52	θ_{TWR}	deg	Angle of total twist of rear rotor blade from reference root at the centerline of rotation to the tip. Positive leading edge up at blade tip.
53	X_{CR}	-	Rear rotor radius ratio for blade cutout
54	$k_{\beta R}$	-	Rate of change of rear rotor blade pitch angle with rotor blade flap angle. Equal to - tan δ_3

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NO.	SYM	UNIT	DEFINITION
117 to 125	σ_1 to σ_9	-	The solidity (based on local chord $bc_\eta/\pi R$) value corresponding to the above X_η stations. Leave blank if solidity is input in equation form.
126 to 134	θ_{TW_1} to θ_{TW_9}	-	The twist value (θ_{TW_η}) corresponding to the specified X_η location. Leave blank if twist is input in equation form.

NOTE: C-70 input descriptions indicate how to calculate the required trim data and identify the appropriate A-97 output needed.

RETURN TO:		TRIM AND STABILITY ANALYSIS FOR TANDEM HELICOPTERS	AIRFOIL DATA $C_L + C_D$ TABLE 1		TABLE 2		TABLE 4	
PROGRAM A-97 BOMAC	HELICOPTER MODEL CH-47C				TABLE 3		TABLE 5	

INPUT NO.	SYM	UNIT	CASE NO.	
1	V	KNOTS	123.	
2	R/C	FT/MIN	0.	
3	$G.W.$	LBS.	38865.	
4	H_P	FT.	6476.	
5	T	°F	46.	
6	β_F	DEG.	0.	
7	α_{FF}	LBS/HR	0.	
8	β_{FF}	LBS/HR / SHP	0.	
9	K_{FF}	—	1.05	
10	N_{FF}	—	1.	
11	η_F	—	0.94	
12	η_R	—	0.94	
13	BHP_{ACC}	HP	0.	
14	V_{HW}	KNOTS	0.	
15	fe	FT²	46.5	
16	Δu	FT/SEC	0.	
17	Δv	FT/SEC	0.	
18	Δw	FT/SEC	0.	
19	Δp	DEG/SEC	0.	
20	Δq	DEG/SEC	0.	
21	Δr	DEG/SEC	0.	
22	$\Delta\delta_C$	DEG.	0.	
23	$\Delta\delta_B$	IN.	0.	
24	$\Delta\delta_L$	IN.	0.	
25	$\Delta\delta_R$	IN.	0.	
26	R_F	FT.	30.	
27	C_F	FT.	2.1042	
28	b_F	—	3.	
29	e_F	FT.	0.6667	
30	σ_{IF}	—	0.	
31	θ_{TWF}	DEG.	-9.137	
32	X_{CF}	—	0.195	
33	k_{BF}	—	0.	
34	i_F	DEG.	9.	
35	V_{TF}	FT/SEC	722.6	
36	I_F	SLUGS-FT²	2671.8	
37	M_{WF}	FT-LBS	4612.2	
38	B_{ITF}	DEG.	0.5	
39	$B_{ICF\delta_B}$	DEG/IN	0.	
40	$A_{ICF\delta_L}$	DEG/IN	0.	
41	$A_{ICF\delta_R}$	DEG/IN	0.	
42	θ_{TF}	DEG.	0.	
43	$\theta_{F\delta_B}$	DEG/IN	0.	
44	l_F	FT.	20.8	
45	h_F	FT.	7.35	
46	d_F	FT.	0.	
47	R_R	FT.	30.	
48	C_R	FT.	2.1042	

INPUT NO.	SYM	UNIT	CASE NO.	
49	b_R	—	3.	
50	e_R	FT.	0.6667	
51	σ_{IR}	—	0.	
52	θ_{TWR}	DEG.	-9.137	
53	X_{CR}	—	0.195	
54	k_{BR}	—	0.	
55	i_R	DEG.	4.	
56	V_{TR}	FT/SEC	722.6	
57	I_R	SLUGS-FT²	2671.8	
58	M_{WR}	FT-LBS	4612.2	
59	B_{ITR}	DEG.	1.1	
60	$B_{ICR\delta_B}$	DEG/IN	0.	
61	$A_{ICR\delta_L}$	DEG/IN	0.	
62	$A_{ICR\delta_R}$	DEG/IN	0.	
63	θ_{TR}	DEG.	0.	
64	$\theta_{R\delta_B}$	DEG/IN	0.	
65	l_R	FT.	18.1	
66	h_R	FT.	11.95	
67	d_R	FT.	0.	
68	lc	FT.	-1.	
69	hc	FT.	-1.2	
70	d_C	FT.	0.	
71	INT	—	0.	
72	DER	—	0.	
73	F	LBS.	0.	
74	X_{FF}	FT.	0.	
75	Y_{FF}	FT.	0.	
76	Z_{FF}	FT.	0.	
77	ψ_{FF}	DEG.	0.	
78	θ_{FF}	DEG.	0.	
79	I_{XX}	SLUGS-FT²	0.	
80	I_{YY}	SLUGS-FT²	0.	
81	I_{ZZ}	SLUGS-FT²	0.	
82	I_{XZ}	SLUGS-FT²	0.	
83	T_{CHAR}	—	0.	
84	—	—	0.0	
85	θ	DEG.	0.	
86	T_θ	—	0.	
87	T_{LD}	—	0.	
88	T_T	LBS.	0.	
89	θ_T	DEG.	0.	
90	ψ_T	DEG.	0.	
91	X_T	FT.	0.	
92	Y_T	FT.	0.	
93	Z_T	FT.	0.	
94	$\theta_{F\delta_C}$	DEG/IN	0.	
95	$\theta_{R\delta_C}$	DEG/IN	0.	
96	ϕ_{BICF}	DEG.	0.	

INPUT NO.	SYM	UNIT	CASE NO.	
97	ϕ_{AICF}	DEG.	0.	
98	ϕ_{BICR}	DEG.	0.	
99	ϕ_{AICR}	DEG.	0.	
100	N_{TABLES}	—	1.	
101	X_{TAB1}	—		
102	X_{TAB2}	—		
103	X_{TAB3}	—		
104	X_{TAB4}	—		
105	X_{TAB5}	—		
106	$\theta_{TW}, \sigma_{TAB}$	—		
107	N_X	—		
108	X_1	—		
109	X_2	—		
110	X_3	—		
111	X_4	—		
112	X_5	—		
113	X_6	—		
114	X_7	—		
115	X_8	—		
116	X_9	—		
117	σ_1	—		
118	σ_2	—		
119	σ_3	—		
120	σ_4	—		
121	σ_5	—		
122	σ_6	—		
123	σ_7	—		
124	σ_8	—		
125	σ_9	—		
126	θ_{TW1}	DEG.		
127	θ_{TW2}	DEG.		
128	θ_{TW3}	DEG.		
129	θ_{TW4}	DEG.		
130	θ_{TW5}	DEG.		
131	θ_{TW6}	DEG.		
132	θ_{TW7}	DEG.		
133	θ_{TW8}	DEG.		
134	θ_{TW9}	DEG.		
135	IN-PUT		1.0	

NOTE:

Loc 106	= 1	σ-TAB	θ_{tw}-EQN
	= 2	σ-EQN	θ_{tw}-TAB
	= 3	σ-TAB	θ_{tw}-TAB
	= 4	σ-EQN	θ_{tw}-EQN

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13. ABSTRACT

This report provides user's instructions for two computer programs, one for aeroelastic stability analysis and one for aeroelastic prop/rotor loads analysis. These programs are commonly identified by Boeing-Vertol as C-39 and C-70, respectively. Each program is carefully described and explained, symbols and sign conventions are identified, and input and output data are presented. A sample program run for each analysis is then given. In addition, sample programs for subroutines D-01 and A-97, which are used in support of C-70, are provided. Notes and suggestions on program usage are presented.
The methods contained in this report are intended to be used by designers to calculate with improved accuracy, the dynamic and aeroelastic response characteristics of rotor powered V/STOL aircraft. The essential new feature of these methods is that the coupled flap-pitch-lag blade deflections are taken into account. These calculations are essential if a high level of confidence is to be had in the results.

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